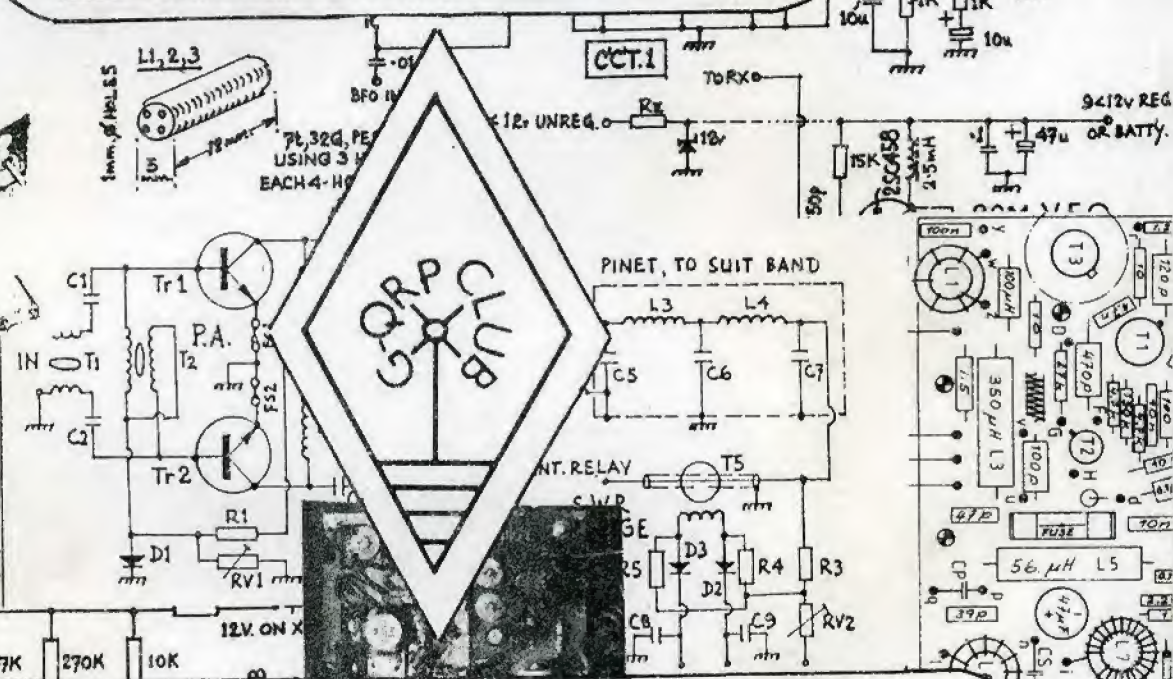
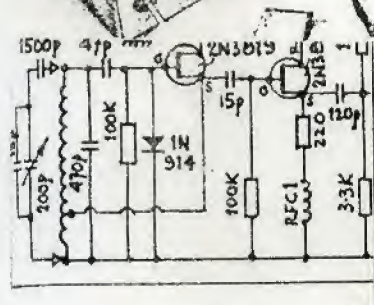
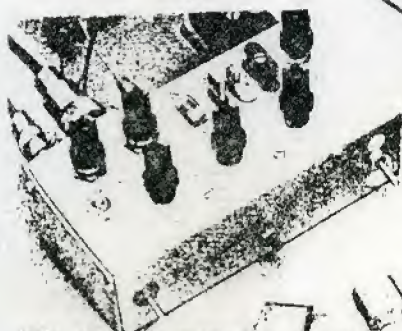
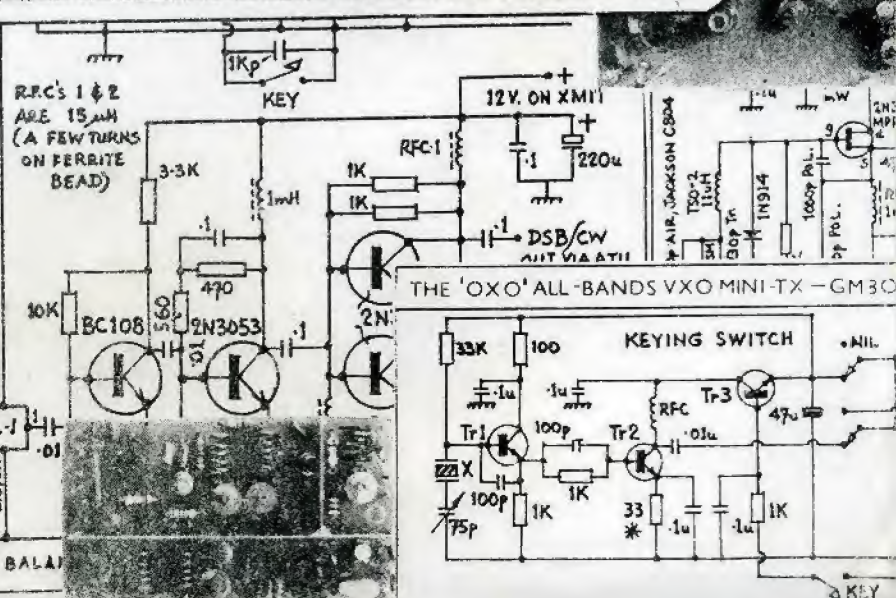
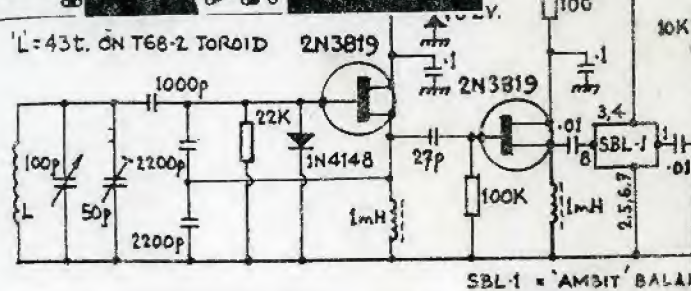
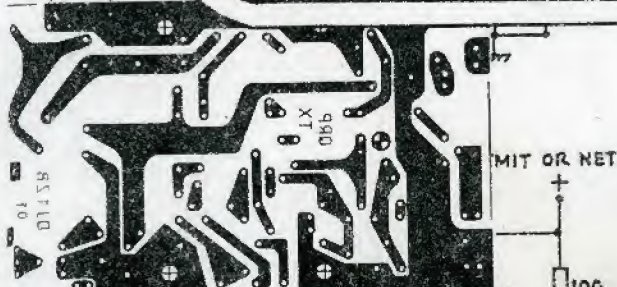


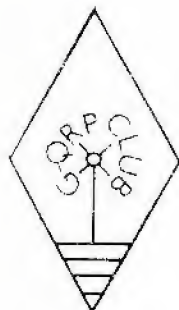
# G-QRP CLUB



# CIRCUIT HANDBOOK







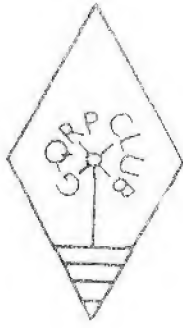
DEVOTED·TO·LOW·POWER·COMMUNICATION

Compiled by Rev. George Dobbs G3RJV  
From the G QRP Club Journal  
SPRAT 1974-82

Artwork Mac McNeill G3FCK  
Text type Dave Lunn G3LSL

© G QRP Club 1983

Further details about the G-QRP Club and a sample copy of SPRAT are available  
from Rev G.C.Dobbs (G3RJV), 17 Aspen Drive, Chelmsley Wood, Birmingham B37 7BX.



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# A CW Transceiver for 20M

Frank Lee G3YCC

Some of the modules used to build this rig were removed from existing equipment; others were built specially. This explains the different devices used for the TX modulator and the RX mixer, the option of two carrier injection oscillators (CIO), and the use of an SSB type filter instead of a cw filter.

The Colpitts VFO circuit has gate clamping to improve stability and is followed by two buffers, the second providing individual outputs to the TX and RX. An RIT circuit operates on receive: it must be correctly set up when first aligning the rig (see later). Coil winding details for the VFO and other stages appear in the associated diagrams. The VFO must be built in a stout metal box and care must be paid to mechanical rigidity.

The RX front end uses 40673 dual-gate MOSFETS. The associated tuned circuits are peaked to the centre of the cw band with the aid of trimmers. The mixer output is link-coupled to a KVG 9MHz ssb filter, whose output is amplified by means of an SL612 IF amplifier ic. The product detector uses two BC107 transistors. Carrier reinjection is from a crystal oscillator using the USB crystal supplied with the KVG filter. Diagrams of an fet oscillator and a pnp bipolar oscillator are given; either can be used, or the circuit polarities can be altered to suit an npn transistor instead. No audio amplifier circuit is shown, but an LM380 ic would be suitable.

The TX mixer is an MD108, fed from the VFO and the lower sideband carrier injection oscillator. (The less expensive 40673 could probably be used as a mixer if desired). The mixer output is applied to an SL610C RF amplifier, then to an fet driver stage which drives a 12BY7A pa similar to that in the well known "Tucker Tin" circuit. Attempts were made to use a transistor PA, but they produced troubles which were almost certainly due to lack of previous experience with transistor PA design. A simple diode/meter circuit is fitted to measure relative power output. Sidetone is provided by an NE555 circuit. Send/receive switching is by means of a 4-pole changeover relay controlled from a switch, one contact set being spare. A reed relay is used for keying. With the VFO and CIO frequencies chosen, 80 metre operation would also be possible by changing the appropriate coils.

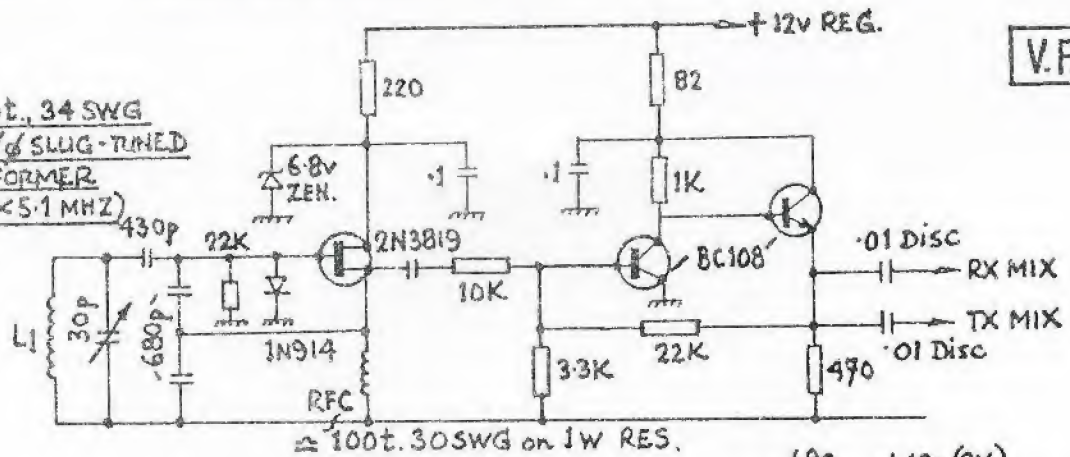
Alignment is conventional except for the RIT, which must be set up as follows if it is to compensate for the frequency difference between the two CIO crystals:-

1. Using an external receiver with no aerial connected, and a signal source such as a crystal calibrator, switch the transceiver to "send" and zero beat it with the signal source.
2. Switch the transceiver to receive, then use the RIT control to zero beat it with the signal source. Carefully mark the setting of the RIT control on the front panel of the transceiver so that it can be accurately repeated.
3. When searching the band, do so with the RIT control set to this mark. If it is required to net on to another station, tune to zero beat, then off-set the RIT control to give the required beat note. After a QSO or an unsuccessful call, always re-set the RIT control to its zero mark in readiness to zero beat with the next station to be called.

So far, the best DX with this rig was when a VK answered a CQ call from G3YCC.

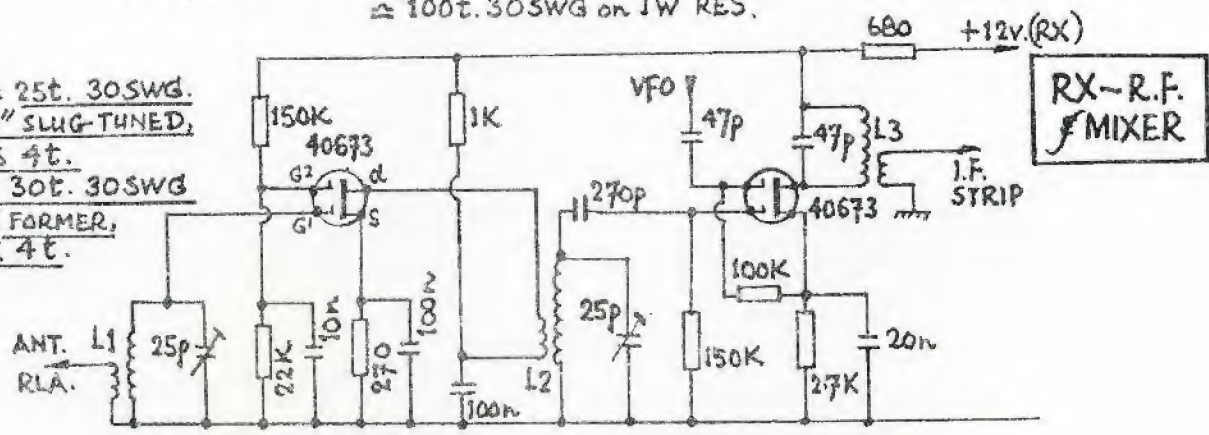


L<sub>1</sub>: 30t., 34 SWG  
ON 1/4" SLUG-TUNED  
FORMER  
(5 < 5.1 MHz)



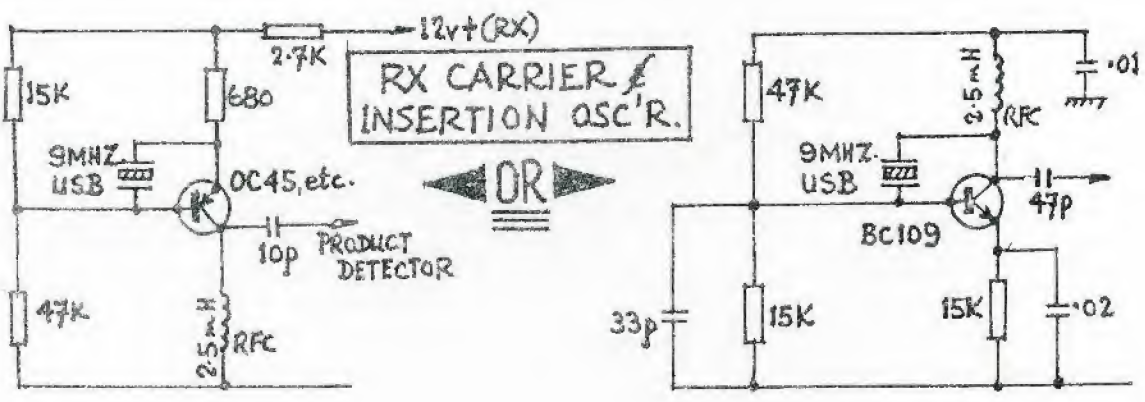
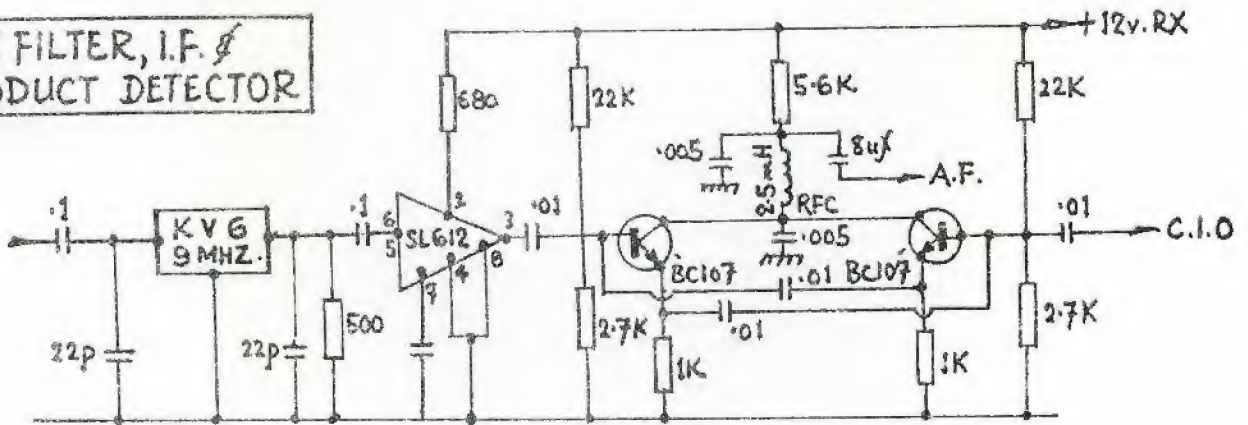
V.F.O.

L<sub>1,2</sub> = 25t. 30SWG.  
ON 1/4" SLUG-TUNED,  
LINKS 4t.  
L<sub>3</sub> = 30t. 30SWG  
1/4" FORMER,  
LINK 4t.



RX-R.F. MIXER

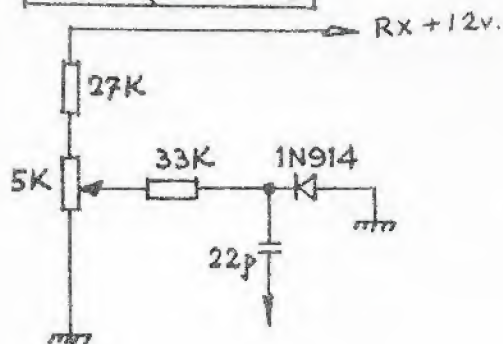
RX FILTER, I.F. & PRODUCT DETECTOR



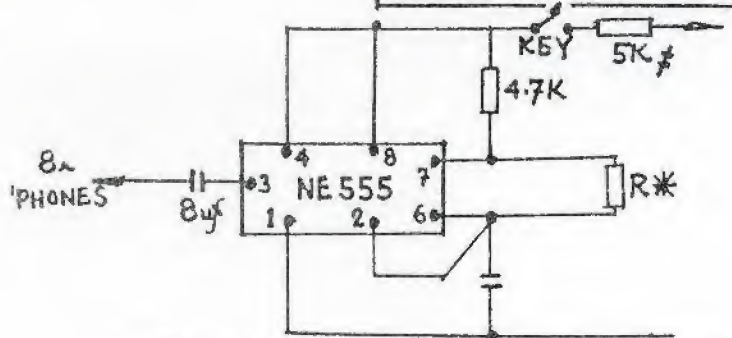
RX CARRIER INSERTION OSC'R.

# 20M. TX-RX (CONT'D.)

## I.R.T. (SEE TEXT)

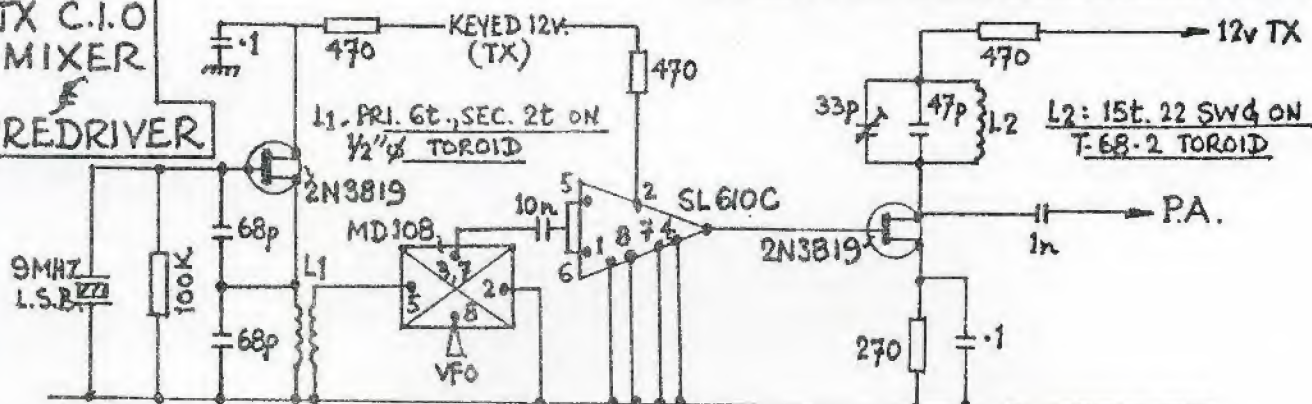


## SIDETONE OSC'R.

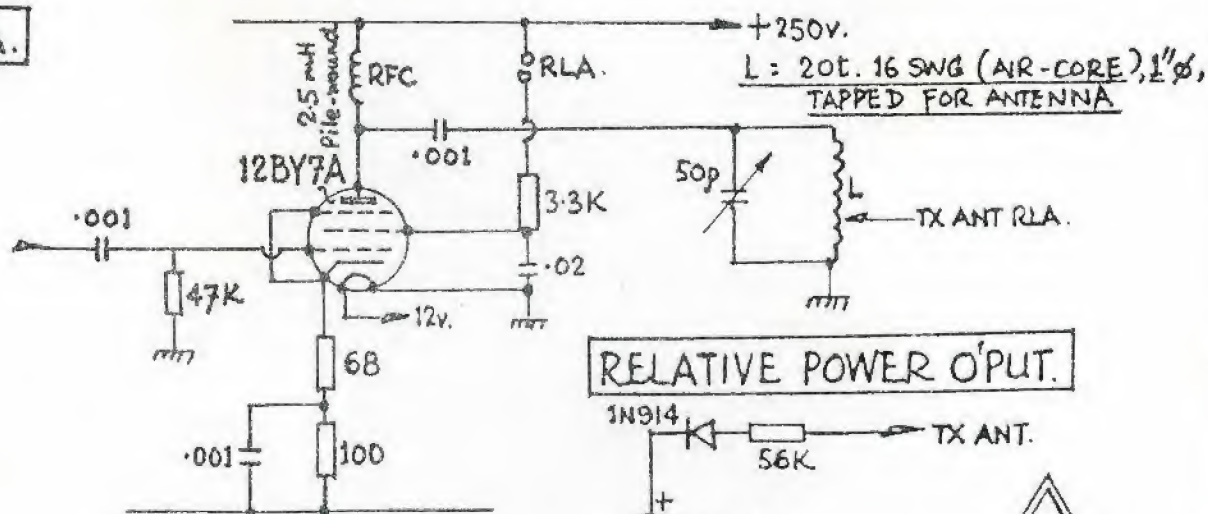


\*R: SELECT FOR DESIRED TONE (10 < 50K)  
 ⚡: VARY INPUT RES. FOR REQUIRED O'PUT.

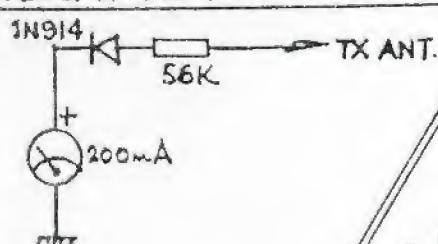
## TX C.I.O MIXER PREDRIVER



## P.A.



## RELATIVE POWER O'PUT.



RELAY IS 4 POLE C/O { 250V. P.A. SCR.  
 12V. TX OR RX  
 E. CH/OVER  
 SPARE (E.G., TRANSVERTER, ETC.)

USE A SEPARATE, REED, RELAY TO KEY TX C.I.O. & SIDETONE

FRANK LEE ——— G-QRP-C ——— NR.042

G3YCC



## The G3IGU 80m Transceiver by Keith Coates G3IGU 5

The circuit is straightforward, the direct conversion receiver is based upon the circuit by J. Young in Radio Communication (February 1975), although the RF amplifier is tuned and an RF gain control was found to be essential for evening use. The AF amplifier is a simpler circuit.

The layout is not very critical. The VFO, EF and BA are very well screened with the components mounted on a length of tag strip. The receiver and sidetone generator are built onto paxolin panels (see diagram), and wired up at the rear. The whole transceiver is built into one box, including the ATU, so that only aerial and earth connections are required. Batteries may also be fitted into the case if desired.

The PA stage may be considered odd, with the 680 and 10 ohm resistors, but several other types of coupling were tried which resulted in accidents to the BFY51. This circuit has never damaged a PA transistor. The actual RF power output will depend upon the transistor used, various BFY51s have given DC power inputs of between 850mW and 1.3 watts.

The AF filter (L5, L6 and L7) is based upon the circuit of J. Young (Rad Com, October 1973) using 38 SWG on Mullard ferrite rings type FX1593. In the prototype, scrap ferrite rings were used and only about 200 turns could be wound onto them, but these appeared to work alright.

The PA and ATU coils are wound on ferrite rod  $\frac{3}{8}$  inch diameter and  $2\frac{1}{2}$  inches long. These are wound with 15 turns of 20 SWG, the ATU coil being tapped every two turns for aerial impedance matching.

Different values of R20 will alter the drive to the PA, giving different power outputs. A 1K ohm preset in series with a 470 ohm fixed resistor will give a variable output from about 200mW to about 1.5 watts, (useful for points in contest operating).

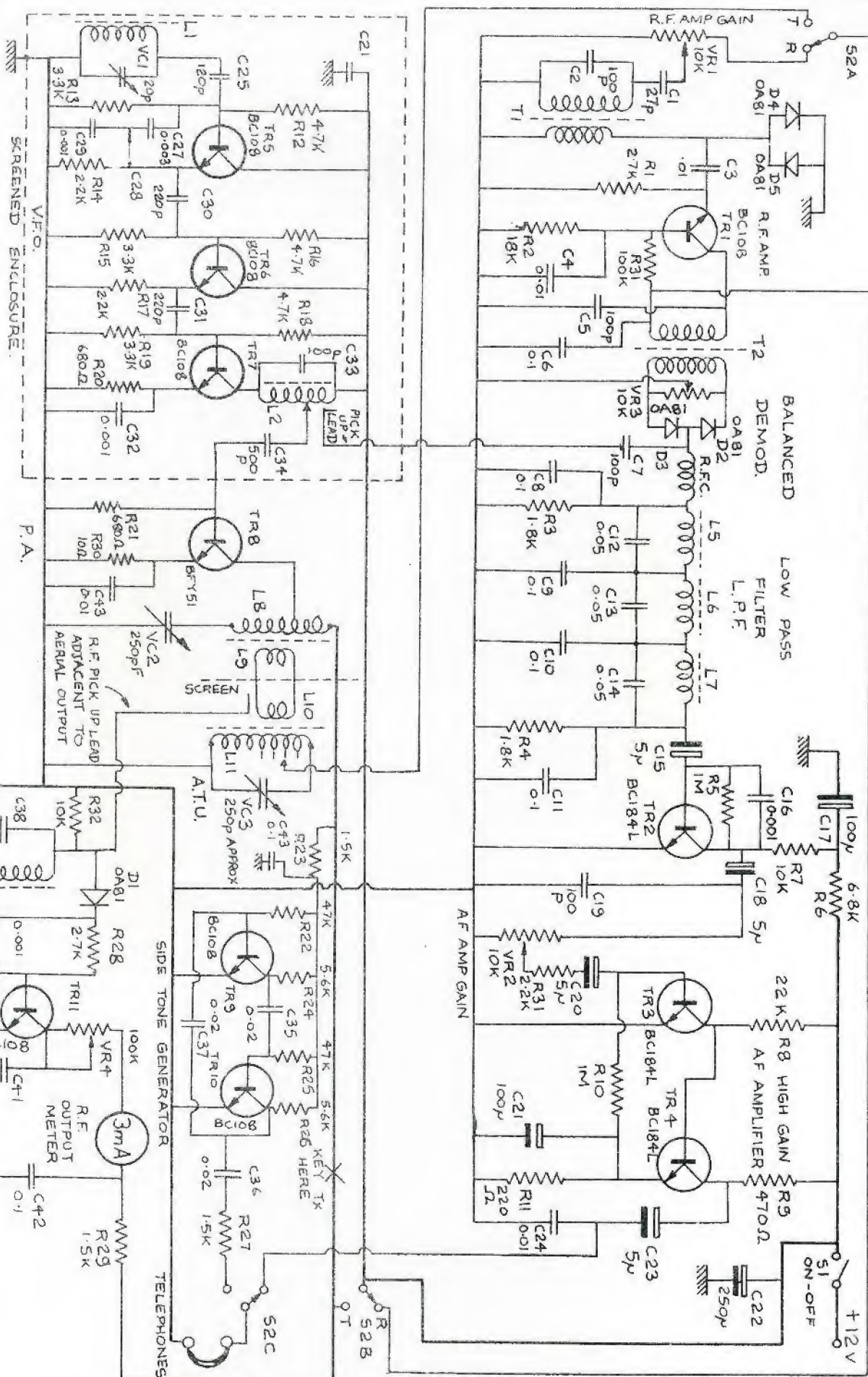
A 500mA fuse should be fitted in the 12 volt supply lead, especially if a car battery is to be used, (and a diode to prevent reverse polarity accidents - G3RJV).

### Suggested Coil Windings (notes by G3RJV)

These notes are based on another 80 metre rig I have built, using some of the information in the J. Young article. A GDO is useful for tuning the coils to resonance.

- T1 Primary: 40 turns 30 SWG closewound on  $\frac{3}{8}$ " former with slug.  
Secondary: 5 turns on earthy end.
- T2 Primary: as T1  
Secondary: 12 turns 34 SWG closewound in the centre of the primary.
- L1 30 turns 30 SWG on  $\frac{3}{8}$ " former with core, with 100pF fixed and 50pF trimmer in parallel to tune onto the CW end of 80 metres.
- L2 As primary of T1, tapped about two thirds up from the earthy end.
- L8 15 turns 20 SWG on  $\frac{3}{8}$ " ferrite rod ( $2\frac{1}{2}$  inches long).
- L9 About  $4\frac{4}{5}$  turn link on L8
- L10 As L9
- L11 As L8 with tapings about every two turns.
- L12 As L2 (or perhaps a 1.5mH RFC)
- L5, L6 and L7 - See AF filter from "The Cadet" Receiver by J. Young (Rad Com, October 1973).

S2: 3 POLE 2 WAY  
ALL TUNED CIRCUITS RESONATE AT 80 METRES.

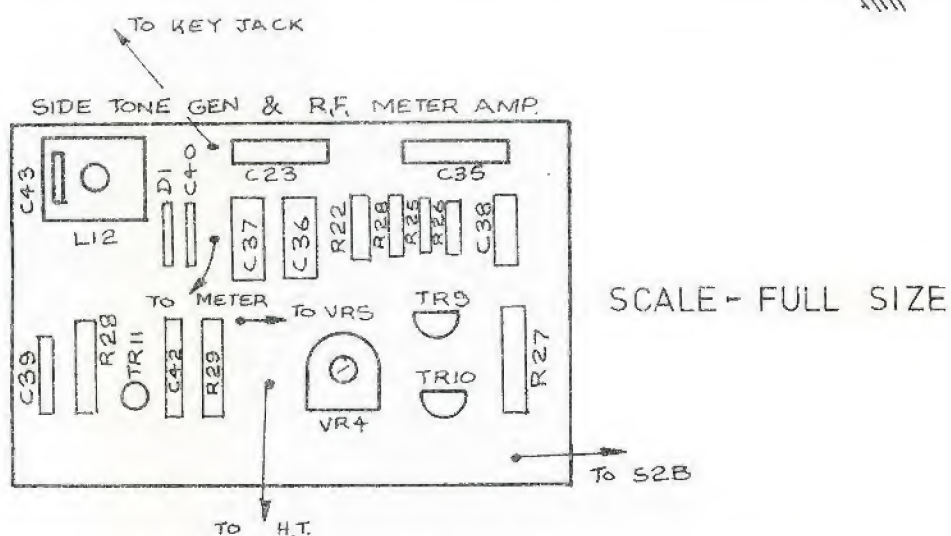
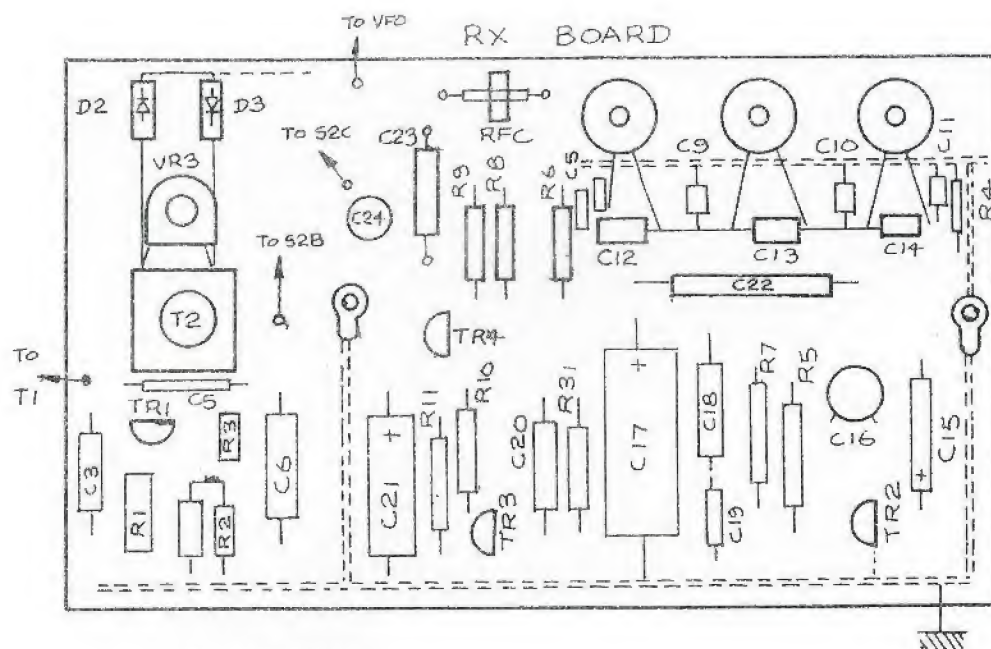


# G3IGU 80m QRP Transceiver

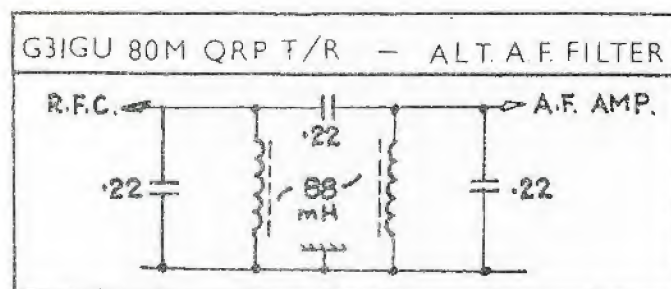
NOTE: AMPLIFIER NOT REQUIRED WITH METERS OF 1 MA OR LESS F.S.D.

DWN	KAS
DATE	13.4.75





## SUGGESTED LAYOUT OF PRINTED CIRCUIT BOARDS



## 8 G3IGU 40-20M Transceiver

This is the HF version of the well-known G3IGU 80 Metre Transceiver, for which Keith Coates won the G2NJ Trophy of 1977/8. The formula is basically the same, with transmitter and direct conversion receiver run from the same oscillator.

In the true amateur radio tradition, this is a "components at hand" project, so we merely offer the circuit and the layout as used by Keith. The switch S1, (an old TV component), may be difficult to duplicate, but individual ingenuity should solve the problem. All the Aladdin coil formers are 1/4" junk-box types. The formers for L8,L9 and L10 were surplus 1/4" ferrite bobbins, filled with wire, but other suitable inductances could be tried, (or even an active filter). L4 is wound on an old broadcast receiver ferrite rod, tapped to suit loading.

By dipping into junk-boxes and salvaging from old equipment, this useful little rig could be built for very little cost,.....and that's what it's all about!

### COMPONENT LIST

CAPACITORS: C1 - 120pF, C2 - 0.1mfd, C3 - 20pF variable, C4 - 3000pF, C5 - 1000pF, C6,C7 - 200pF, C8 - 0.047mfd, C9 - 100pF, C10 - 1000pF, C11 - 100pF, C12 - 200pF, C13 - 50pF, C14 - 1000pF, C15 - 5000pF, C16 - 0.01mfd, C17,C18 - 0.05mfd, C19 - 5000pF, C20 - 0.01mfd, C21 - 500pF (Twin gang RX type, one section), C22 - 1000pF (Twin gang RX type, both halves strapped), C23 - 0.01mfd, C24 - 35pF, C25 - 100pF variable, C26 - 0.1mfd, C27 - 500pF, C28,C29,C30,C31 - 0.1mfd, C32,C33,C34 - 0.05mfd, C35 - 0.01mfd, C36 - 10mfd, C37 - 0.1mfd, C38,C39 - 2mfd, C40 - 100mfd, C41 - 0.01mfd, C42 - 100mfd, C43 - 10mfd, C44,C45 - 0.1mfd, C46,C47 - 2mfd, C48 - 50mfd, C49 - 20pF, C50 - 1000pF.

RESISTORS: R1 - 4K7, R2 - 3K3, R3 - 2K2, R4 - 3K3, R5 - 4K7, R6 - 2K2, R7 - 4K7, R8 - 3K3, R9 - 680, R10 - 100, R11 - 4K7, R12 - 3K3, R13,R14 - 680, R15 - 10, R16 - 680, R17 - 1K, R18,R19 - 1K8, R20,R21 - 1K, R22 - 22K, R23 - 470K, R24 - 120K, R25 - 47K, R26 - 10K, R27 - 220, R28 - 1K, R29 - 2K2, R30 - 5K6, R31 - 1K, R32 - 100K, R33 - 22K, R34 - 470, R35 - 8K2.

POTENTIOMETERS: P1 - 10K preset (det balance), P2 - 10K preset (sidetone level), P3 - 10K (AF gain), P4 - 1K (RF gain)

DIODES: D1, D2, D5 - OA81, D3, D4 - ITT44

TRANSISTORS: TR1,TR2,TR3,TR5 - BC108, TR4 - BC182, TR6,TR7 - BFY51, TR8 - BF256, TR9,TR10,TR11 - BC184, TR12 any pnp audio type, TR13,TR14 any npn audio type.

INDUCTORS: L1 - 35 turns in pot core. L2 - 24 turns, tapped 9 turns, on Aladdin former. L3 - 15 turns tapped at 5 and 8 turns on Aladdin former. L4 - 12 turns on ferrite core, 1 1/2 inches long. L5 - 7 turns wound over L4. L6 - 24 turns on Aladdin former. L7 - 8 turns bifilar wound over L6. L8,L9,L10 - 280 turns on small ferrite core.

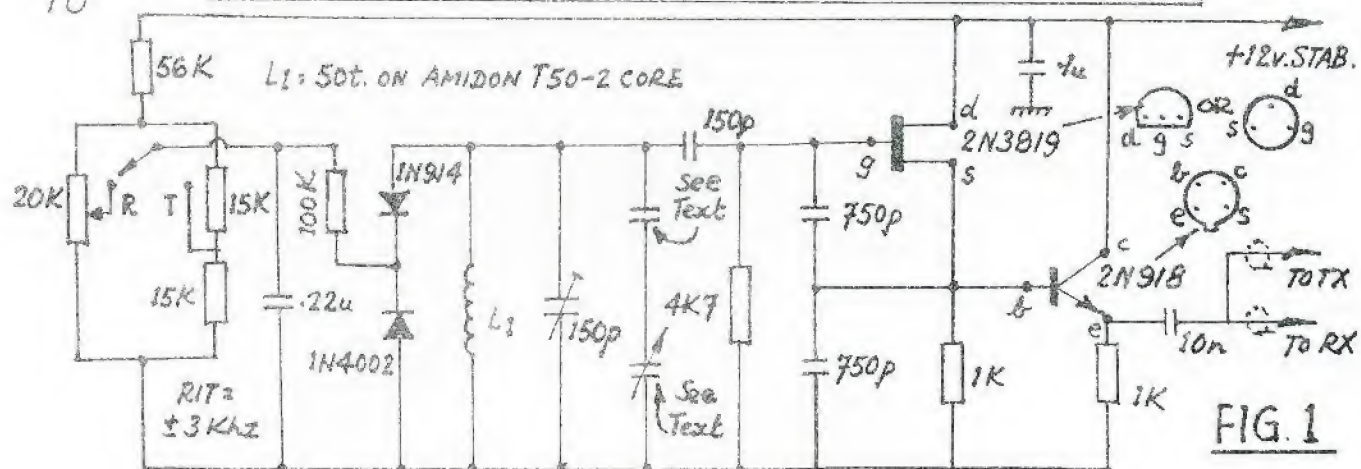
SWITCHES: S1 - single pole. S2 - 4 pole, 2 way rotary. S3 - 5 pole, 2 way (original uses ex-TV slider system switch 8" long).

FUSE: 500mA (with holder).

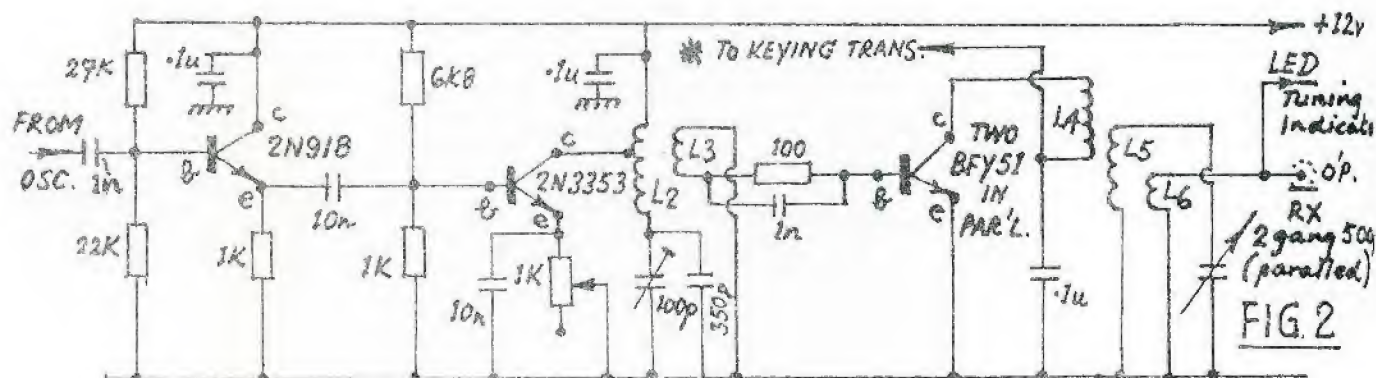




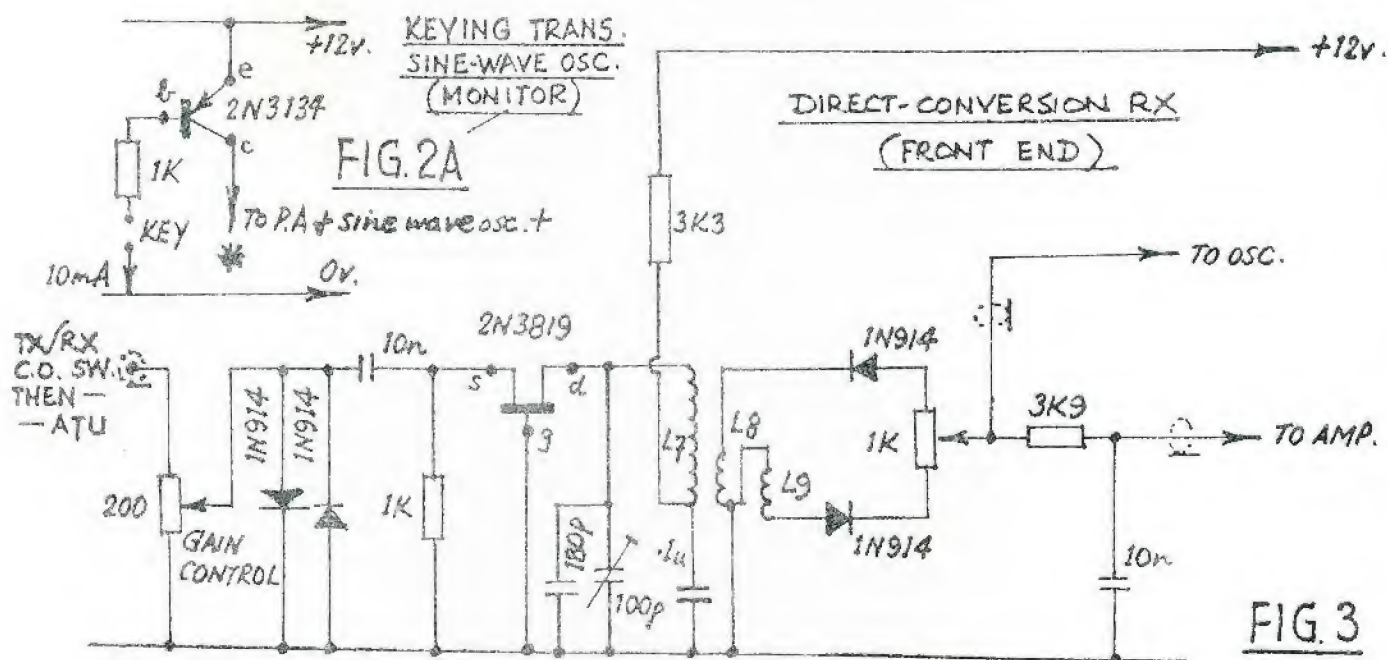




TRANSMITTER



L2: 30t, T50-2 CORE, TAPPED 9t FROM COLD END — L3: 4t. —  
 — L4: 25t, T50-2 CORE — L5: 6t — L6: 6t. —



L7 = 40t on Amidon T50-2 core — L8 and L9 are bifilar-wound, 6t links spread around the complete core.



# AUDIO STAGES

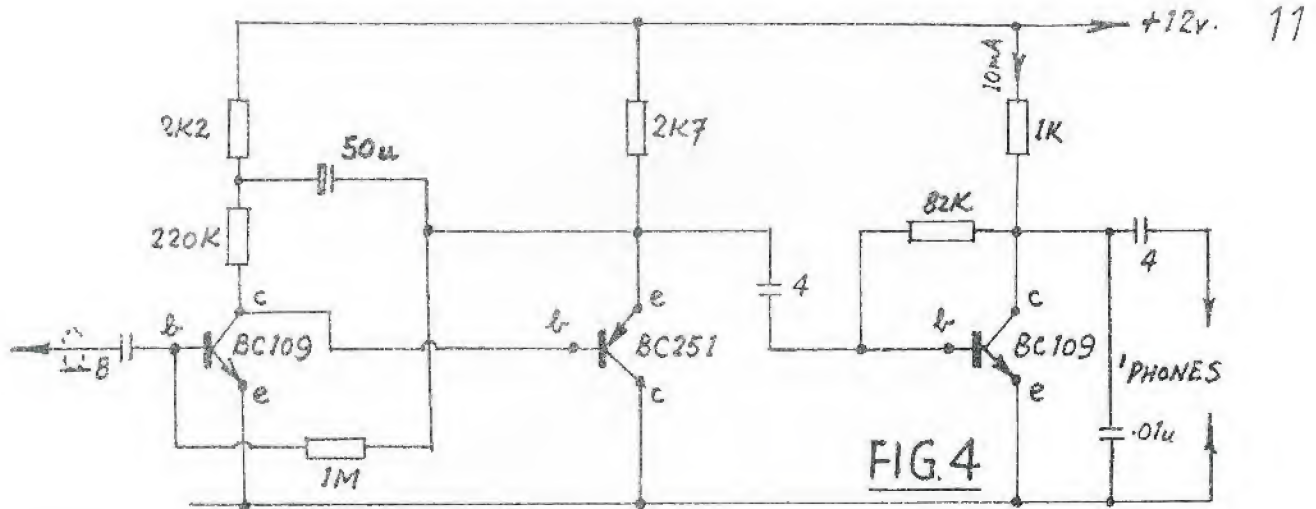


FIG. 4

## SIMPLE TX-TUNING DEVICE

## POWER SUPPLY

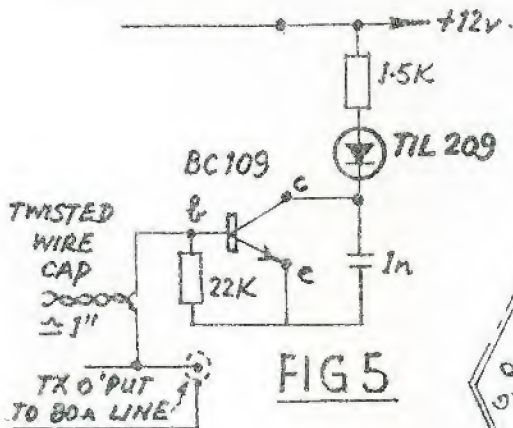


FIG. 5

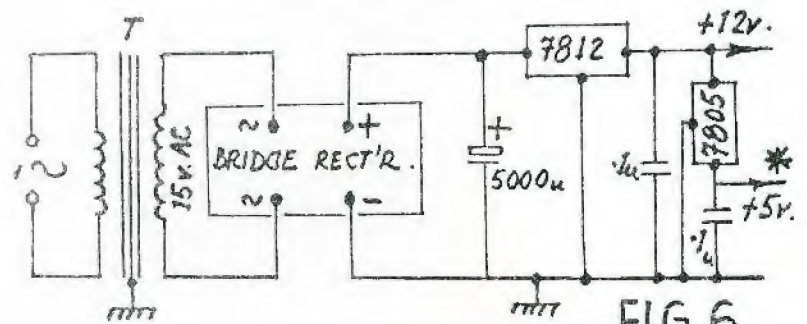
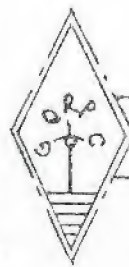


FIG. 6

\*For keyer and ancillary eqpt. only



G3GWI

NORMAN SPIVEY  
G-QRP-C.

## LAYOUT

## DETAIL OF ALI. SCREEN

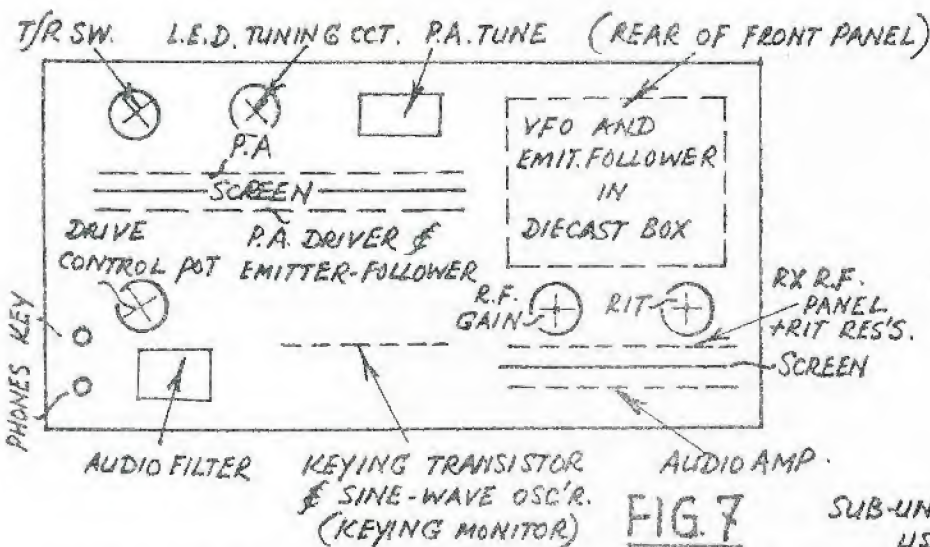


FIG. 7

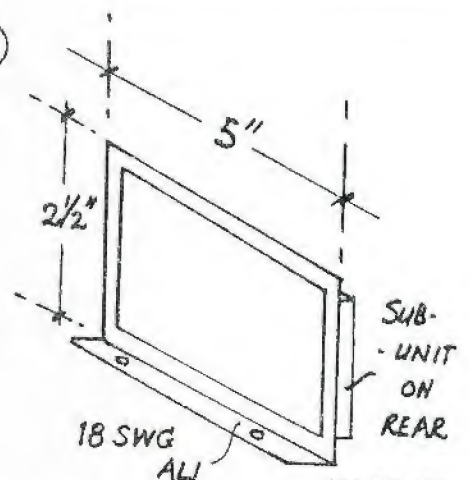


FIG. 8

SUB-UNIT ON MATRIX BOARD,  
USING YERO PINS

NOTE~ THERE ARE TWO SUB-UNITS (1) HAS P.A. ON ONE SIDE, AND DRIVER PLUS EMITTER-FOLLOWER ON THE OTHER SIDE (2) HAS RX R.F. AMP., DETECTOR AND SOME OF RIT. C.C.T. ON ONE SIDE, A.F. AMP. ON THE OTHER SIDE

## The EBOR 3.5MHz Transceiver G3GWI

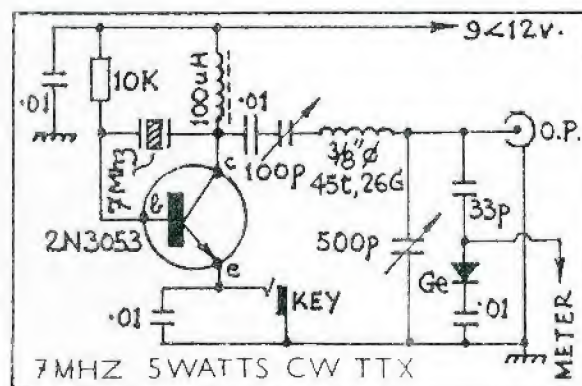
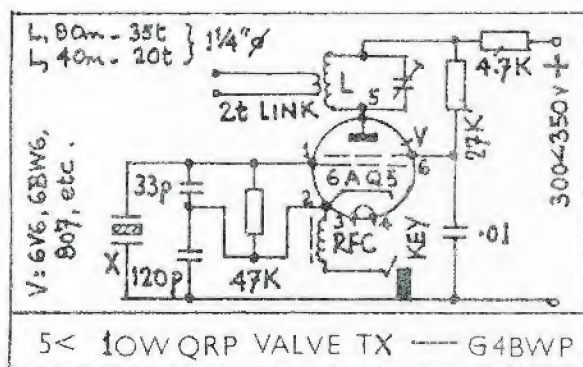
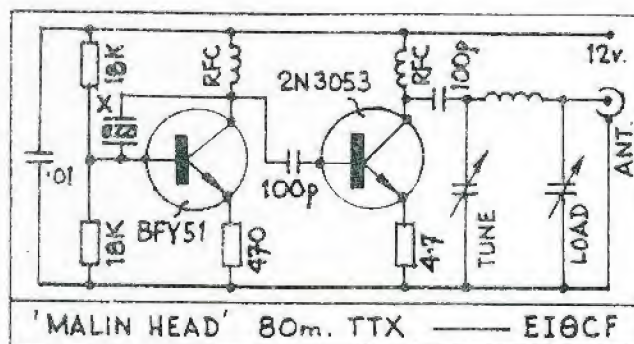
This 3.5 MHz rig illustrates how various circuits from "SPRAT" data sheets and other radio journals can be combined to produce a rig tailored to personal needs. The VFO (Fig 1) uses the very stable Seiler oscillator. Switchable RIT is provided. The bandspread circuit requires about 15pF swing to cover the CW portion of 3.5, and 25pF to cover the whole band. The RX front end (Fig 3) was originally described in Radio Communication. The 200 ohm input potentiometer controls the RX gain. The AF amplifier (Fig 4) provides good gain at low noise while requiring few components. The TX (Fig 2) employs a 2N3353 driving a pair of parallel-connected BFY51 transistors. They must be fitted with push-on heat sinks. (An attempt to use 2N3353 in the PA produced TVI!).

The PA 12v line is keyed via a keying transistor (Fig 2A) which can also be used to key the supply to a sidetone oscillator (not shown). The transmitter output is tuned with the aid of an LED indicator (Fig 5). The twisted wire coupling capacitor should be adjusted until the LED provides an adequate indication at full RF output. The power unit (Fig 6) provides 12v for the TX/RX: the additional 5v output is used to power an el-bug. The physical construction is shown in Figs 7 & 8. All sub-units are mounted at right-angles to the front panel, with the VFO housed in a die-cast box. Where necessary, screens are placed between sub-units.

Send/receive switching uses a double-pole switch to change over the antenna, switch the 12v supply from the RX to the TX, and switch the RIT from R to T (see Fig 1).

(An additional switch connected across the R and T contacts in Fig 1 would allow the RIT to be switched to the T position when on receive, thus allowing accurate netting. Ed.)

### Three Simple QRP Transmitters





# Tunbridge SSB/CW Transceiver G3R00 13

This transceiver was developed to show the Tunbridge Wells Club members the problems of designing transceivers for the new bands, (especially 10MHz). The first problem with this band, when using a 9MHz crystal filter, is that of breakthrough. However, this is not too difficult to overcome, with balanced mixers and traps in the preselector circuits. The insidious problem is the VFO design. The first trap for the unwary is to think "that's easy, a nice stable 1MHz VFO... no problem". Hal!, not so easy, remember that mixers are non-linear devices at the best of times. The VFO signal in most integrated balanced mixers is made to switch transistors on and off; this produces lots of lovely harmonics of the VFO frequency. Taking a case in point, the 1MHz signal we were going to mix with incoming 10MHz signals to produce the 9MHz IF signal. Let's look at the second harmonic of the 1MHz VFO signal. Remember that this 2MHz signal is almost as potent as the proper mixing signal at 1MHz. It will mix with signals at 11MHz to produce an IF signal at 9MHz. Now take a listen to the signals on 11.5MHz - some are over S9 plus 60dB! No amount of "trapping" will get rid of them completely. I hope that this will give you some insight into why certain decisions were made in this design.

## The Receiver

To simplify construction and make reproduction certain, the Plessey SL series of ICs were used. A second advantage is that Birketts (of Lincoln, England), sell these ICs very cheaply as unmarked, untested devices. A sample batch produced a fallout of about 20%, the remainder had adequate performance for this rig. The XF9B filter was used because it was available; if an alternative is used it must have a stop-band of at least 90dB. The incoming signal from the aerial is preselected by three loose top-coupled tuned circuits; the bandpass characteristics of this circuit are adequate for all bands except 10MHz, where two more series tuned circuits are used as traps for any signal at 9MHz which might cause IF breakthrough. The filtered signal is passed to an SL610 wideband amplifier, the amplified signal is then mixed with the local oscillator signal to produce the IF signal at 9MHz. The IF signal, filtered by the XF9B, is further amplified by two SL612s. These are untuned amplifiers and produce a lot of noise of their own, but we are lucky because this receiver is only for SSB and CW signals. We can therefore use a product detector and the unwanted noise (which is ultrasonic) is filtered out in the audio stages by restricting the response to a few KHz. An SL640 is used for the product detector and the audio output is amplified by an SL630. This is sufficient to drive an 80 ohm speaker to comfortable level, or more than enough for headphones. There is no provision for AGC on the receiver PCB, but it would not be difficult to add a small PCB on the underside of the board with an SL621 AGC device, if desired.

## The Transmitter

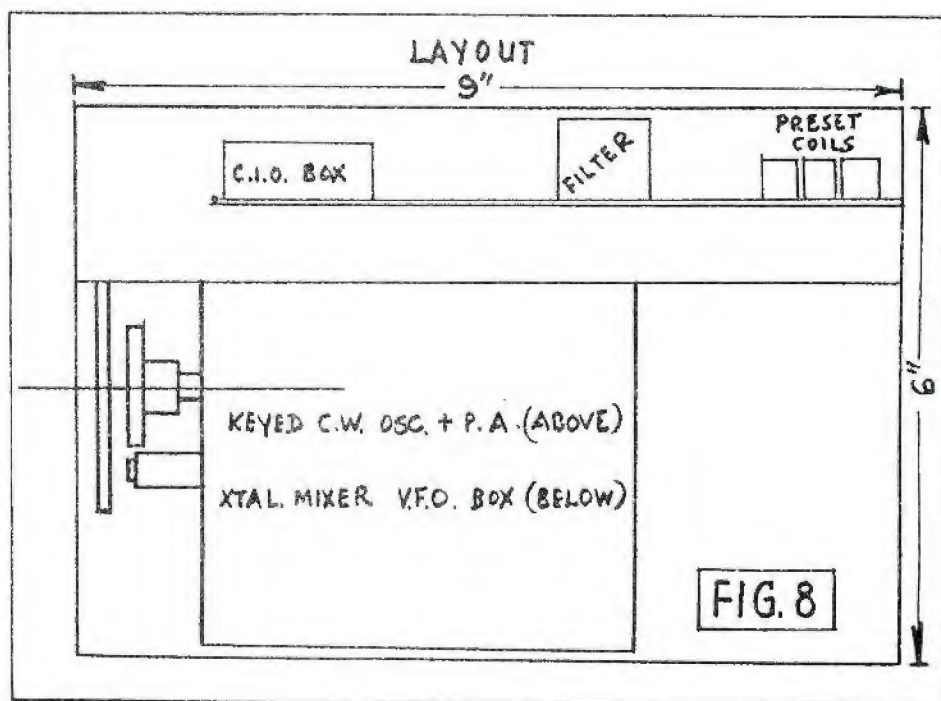
The transceiver is mainly designed for SSB but an input for a keyed oscillator at 9MHz is included so the unit can easily be converted to CW by the addition of this stage. To describe the transmitter action we naturally start at the microphone! The speech signal is fed to an SL630, raising the level sufficiently to drive the signal input of an SL640. Here the audio is mixed with the 9MHz CIO signal to produce a 9MHz DSB signal at its output. This is amplified by an SL610 and passed through the XF9B to remove the unwanted sideband. These three stages are fed from a separate supply pin on the PCB so that, if CW is required, the supply can be removed, disabling this generator. The filter output is fed to an SL641 to mix the 9MHz signal on to the required band, (the keyed 9MHz signal is also fed into this device for CW). The output of the SL641 has a single tuned circuit, the output of which (on the required band) goes to an SL610 for amplification to a suitable level for driving a linear amplifier. More signal filtering is required prior to main amplification and, as the SL610 cannot drive a tuned circuit, a transistor is used as an "interface". By adjusting the emitter resistor, the drive level can be varied to the "linear".

### The VFO

To overcome the problems described earlier, we must position the VFO on the "high" side of the band in use. Using 10MHz again as an example, with coverage from 10.0 to 10.2MHz, the IF is 9MHz so we require the VFO to tune from 19 to 19.2MHz. It could be done, but I would rather leave it to someone else! The cheat's way out is to use a crystal mixer VFO and, with an SL641 balanced mixer, it is fairly easy. If the VFO tunes from 2.1 to 2.3MHz and mixes with a 16.9MHz crystal oscillator, one of the outputs will be in the range 19 to 19.2MHz (the sum). This can be filtered by a couple of tuned circuits and amplified by an SL610. The two "balance" potentiometers should be adjusted by coupling the output of the unit to a general coverage receiver. First listen to the 16.9MHz signal and adjust the crystal balance, then listen to the 2.1MHz signal and adjust the VFO balance for a null. Care must be taken during this procedure to ensure that the signal you are listening to is coming from the output and is not stray radiation from poorly decoupled supplies, inadequate screening, etc.

### Tuned Circuits

A few words are necessary here, as this rig is made for use on any band. The coils used were wound on "Ambit" (Brentwood, UK) coil formers (type 10K) and all the necessary coil winding details are given in their catalogue. Alternatively, with slight modifications to the PCB, their standard range of coils could be used. Reference the ratios of the windings, 50 ohm link windings should be about  $\frac{1}{8}$ th of the main winding and the tuned circuits driving the SL610s should be about  $\frac{1}{4}$  of the main winding. On the two signal transformers in the transmitter, the tap should be at the half-way point.



QRP SSB Calling Frequencies:

14825

21285

28885









# THE 'JU 6 PLUS'

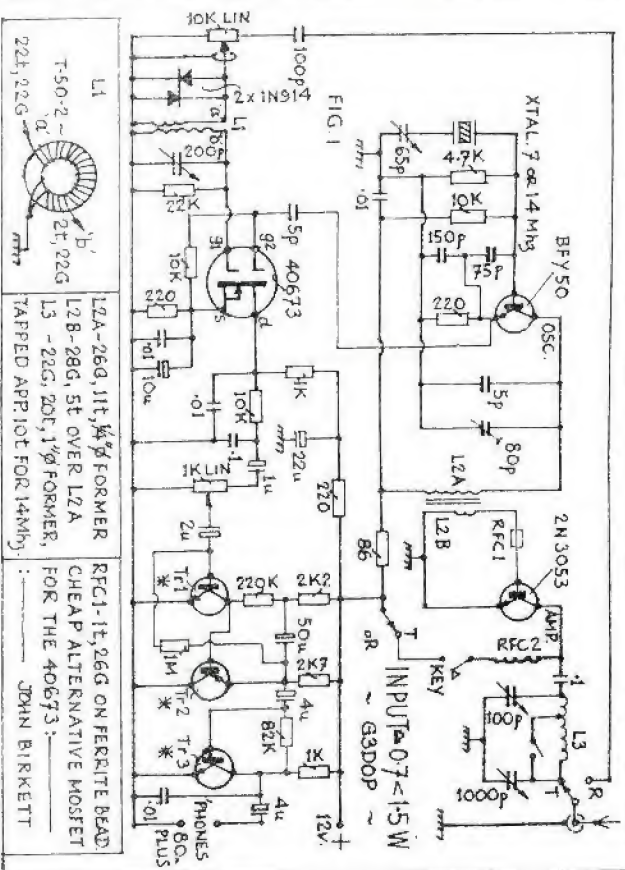


FIG 1

ALTERNATIVES	Tr1	BC318	BC171	BC414
*	Tr2	BC321	BC25	BC416
	Tr3	BC318	BC171	BC414

CROC CLIP, TO SHORT OUT COIL SECTION NOT REQUIRED

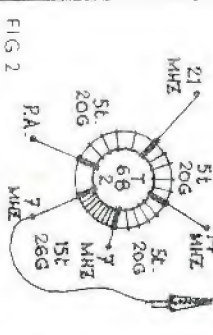


FIG 2

The complete circuit above shows the full transceiver with two modifications: Improved receiver input circuit as suggested by G3RJV in "SPRAT" 21. Improved audio amplifier as suggested by G3IEB. This amplifier is, in fact, the circuit used by G3GMI in the "Ebon" transceiver in "SPRAT" 19. It is low noise and high gain, accepting headphones in the medium to high impedance range.

ALTERNATIVE 3 BAND PA COIL (G3IEB)

Fig 2 shows a 3 band tapped coil on a 168-2 former used by G3IEB in his JU6. The coil is wound as shown, a switch can be used in place of the croc clip. This coil enables the PI network in the PA output to be tuned on the 7, 14 and 21MHz bands. George trebles 7MHz crystals on to 21MHz, but has the 80pF trimmer for L2A as an airspaced variable capacitor on the front panel. With care, L1 will tune all 3 bands on the receiver input. The 10K lin. attenuation pot in the input is important with such a simple receiver input tuning.

The original JU6 Transceiver by John McDonnell, G3DOP, appeared in a half page article in "SPRAT" 20. Since that time it has been built by many club members with various modifications and additions. The article won the G3NU Trophy for the most popular "SPRAT" article in the period 1978-80.

WHAT DOES JU6 MEAN? - A Junk box transceiver with 6 active devices...

## AUDIO PREAMPLIFIER (G3RJV)

Originally from the S.C.D. this pre amp can be a great help if placed between the 40673 mixer and the AF gain control. It can be mounted on the back of the 1K audio gain pot.

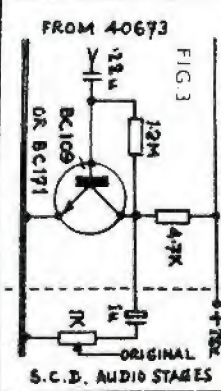


FIG 3

## SIMPLE SIDETONE (G3RJV)

Suggested in "SPRAT" 21, this simple single UJ circuit with its output fed directly to the headphone socket. Ideal for avoiding "deaf keying". It is also useful to incorporate switching in the T/R circuit to switch the AF amp off during transmit to stop loud thumps.

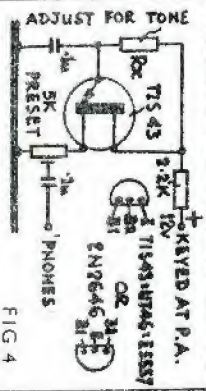


FIG 4

SIMPLE SIDETONE - G3RJV

CRYSTALS SUITABLE FOR THE JU6... are available for the GRP calling channels 7030, 14060, 21060 from P.R.Gollidge Electronics, Merriott, Somerset, U.K. at the special Club price of £3.00 each inc.

## ACTIVE AUDIO FILTER (G3RJV)

Basic one stage op amp filter. With this filter in circuit, the AF pre-amplifier will be required.

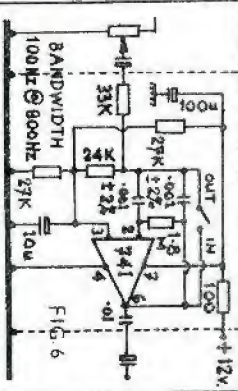


FIG 6

ACTIVE AUDIO FILTER - G3RJV

## PASSIVE AF FILTER (EI1DA)

Hal's beautifully simple idea is merely a capacitor across the leads of a pair of Hi-Z phones to tune the windings. "C" is adjusted to give an AF peak with individual phone sets. Hal also runs a VFO directly into the JU6 first TX stage for variable frequency operation.

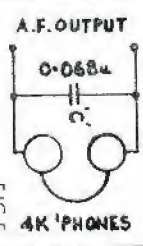
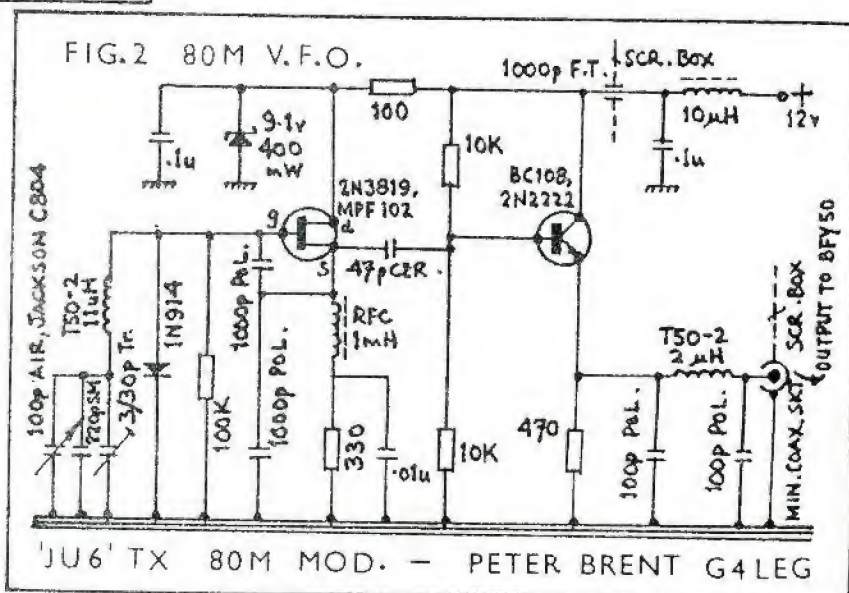
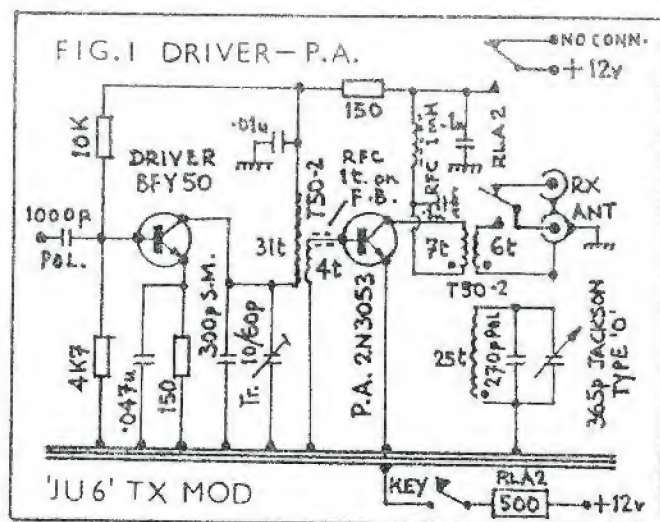


FIG 5

SELECT 'C' VALUE FOR INDIVIDUAL 'PHONES AND TASTE	A.F. OUTPUT
	0.068u
	4K 'PHONES

FIG 5



This circuit is the transmitter side only of the "JU6", changed to the 80 metre band and converted to VFO control. The original BFY50 VFO stage is converted into a driver, by removing the feedback capacitors. The driver tank is re-calculated and more capacitance added to resonate at 3.55MHz (note: no tap on coil).

The 2N3053 PA is altered for single PA tuning control. Note the similarity to "Denco" coils (U.K.). These, however do not work well and the tank details given, although experimental, were found to produce 500mW, measured on a GM30XX wattmeter/dummy load, with a 20Kohms/volt VOM.

VFO decoupling and shielding is essential. Supply line radiation gives S5 on an HA600 receiver, dropping to S1 when all shields are in place. Inductances are calculated values and give the range shown in my prototype.

For alignment, set the VFO (with the trimmer) for 3.5MHz with the main capacitor vanes almost fully meshed. Set the VFO to 3.57MHz and trim the driver tuning for maximum output to a dummy load or wattmeter, with the PA capacitor 1/3 to 2/3 open. Peak the PA tuning from the front panel. Note: about 100mW output will be available over the whole range of the driver trimmer; with the values given, only one peak will be found at the VFO frequency.

Note that as the PA tank has been re-designed for single panel control, second harmonic suppression is not as good as in the original circuit, so a "clean" drive signal is required. The driver (ex-VXO) tank was re-calculated to suit a "parts to hand" toroid, but a T50-2 is satisfactory.

The inductance values are approximate calculated values. The VFO coverage given is that which was obtained with the prototype. In both Fig 1 and Fig 2, all decimal capacitor values are disk ceramic types, "S.M." are silver mica and "Pol" are polystyrene.



George Burt GM30XX

During a recent visit to our Editor, I was asked "Why don't you try some simple gear for a change?". So the following circuit is the result!

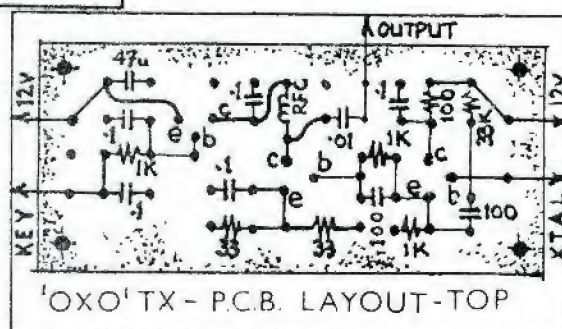
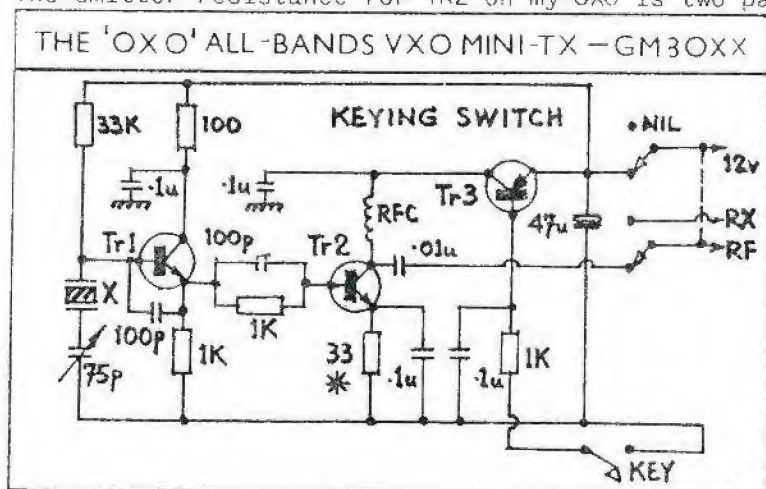
COMPONENT NOTES: TR1 is a BC107. TR2 a surplus computer switching transistor, any suitable PA type would serve, (2N3866 works well). TR3 is a BCY39, which can be left out and a hand key used in its place. RFC = 10 turns 32 SWG on a ferrite bead.

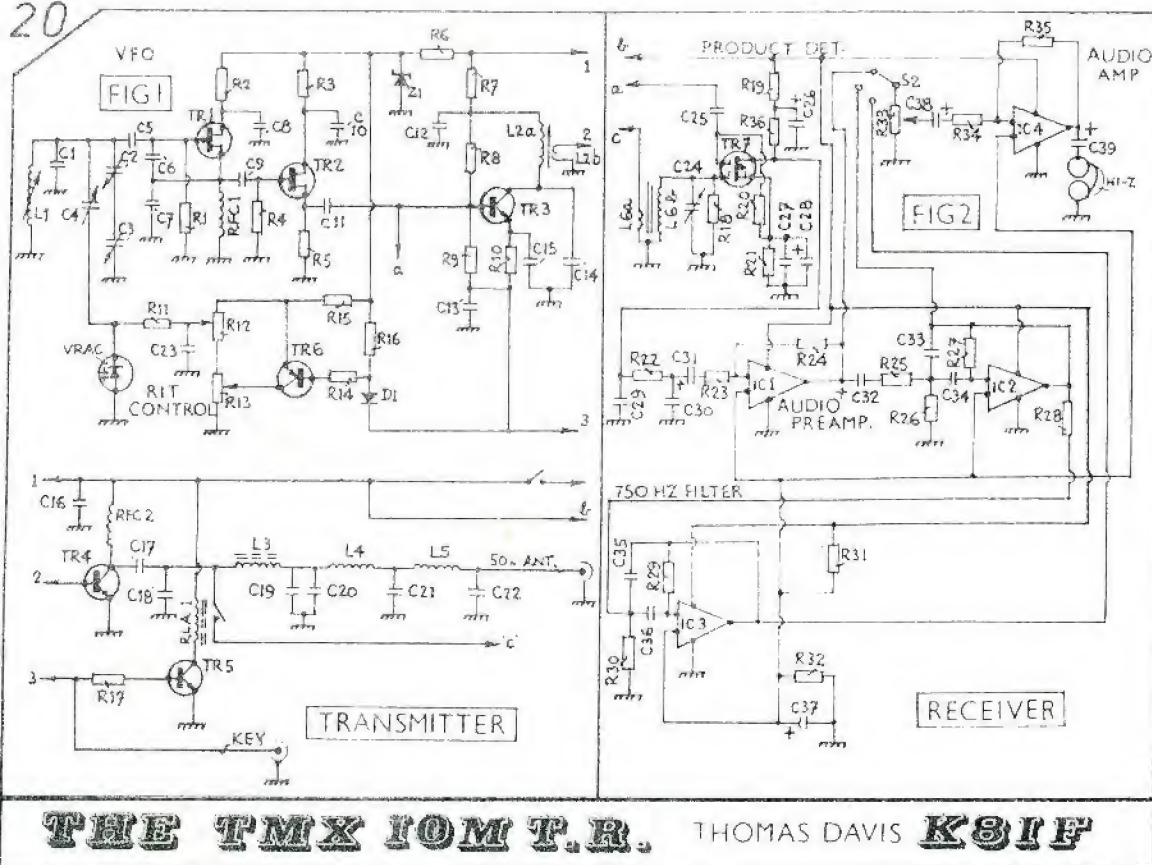
CIRCUIT: This is quite simple, but TR1 is RF and DC coupled to TR2, so the oscillator will not work unless TR2, the 33 ohm resistor and the 0.1 mfd capacitor are connected as shown. Again, do not make the TR2 emitter resistor too small, as TR2 is biased by TR1 and it is easy to make TR2 draw lots of current. The emitter resistor should be adjusted for power in.

The circuit was built on a "blob" board in about 20 minutes, from bits in the junk box and no output tuning was provided. Next, a small PCB was made. As I had no amateur band crystals, a set of crystals from the recent "SPRAT" advertisement was bought. One nice thing was that the 21MHz crystal was found to be a fundamental type. Using the station Z-Match ATU as the output tuning and the DC input adjusted for 1 watt (crystal on), about ten stations were worked in a few hours on 7.03MHz, plus a couple of UAs on 21MHz.

The circuit, which will oscillate with any fundamental crystal (and makes a handy crystal checker) gave 600mW output at 1MHz. Hi! .

(Note from G3RJV:- On the morning I received this circuit from GM3OXX, Colin G3VTT was staying with me. We made PCBs for two "OXO"s that morning and built both rigs that night. First contact was a DL on 40, followed by a 579 report from Italy on 20. When Colin returned home we worked on 80, 'RJV with an OXO and 'VTI with an SCD, and 579 both ways, tuned via a homebrew Z-Match to a G5RV. Try it, it's fun. My layout is as per PCB drawing, with a double-sided PCB front panel. I have an extra 0.1 mfd across the key for shaping and a keying LED from the keyed 12v line. The emitter resistance for TR2 on my OXO is two parallel 39 ohm resistors.





From QRP ARCI 'QRP Quarterly'

C1,5,7,9: 270pF silver mica (SM)	TR1,2: 2N5486 or MPF102
C2,4: 3-30pF trimmer	TR3: 2N2222
C6: 470pF SM	TR4: MPSU-31 or ECG 222
C8,10,12,13,17,27,28,29: 0.01mfd disc ceramic	TR5: 2N3904
C11,15: 230pF SM	TR6: 2N3906
C14: 180pF SM	TR7: 40673 or 3N204
C16: 0.1mfd disc ceramic	R1,4: 47K, 1/4 watt
C18: 1800pF SM	R2,3: 100 ohms, 1/4 watt
C19: 1500pF SM	R5,36: 1K, 1/4 watt
C24: 80pF trimmer	R6: 180 ohms, 1/4 watt
C25: 27pF SM	R7: 10 ohms, 1/4 watt
C26: 20mfd electrolytic	R8,9,15,16: 4.7K, 1/4 watt
C28,39: 10mfd electrolytic	R10: 390 ohms, 1/4 watt
C30: 0.33mfd disc ceramic	R11,35: 100K, 1/4 watt
C31,37: 1mfd electrolytic	R13: 10K pot
C32,38: 2.2mfd electrolytic	R14: 5.6K, 1/4 watt
C33-36: 0.0027mfd disc ceramic	R20: 8.2K, 1/4 watt
C23: 0.001mfd disc ceramic	R26,30: 4.3K, 1/4 watt
C20,22: 300pF SM (see text)	R12: 25K pot
C21: 600pF SM (see text)	R17: 56K, 1/4 watt
D1: 1N914 diode	R18: 20K, 1/4 watt
RLA1: Reed relay, 12v normally open	R19,23: 220 ohms, 1/4 watt
L1: 6 turns 24SWG on 1/2" slug-tuned former	R21: 120 ohms, 1/4 watt
L2a: 11 turns 24SWG on 1/2" slug-tuned former	R22,31,32: 3.9K, 1/4 watt
L2b: 2 turns 24SWG over L2a	R24: 390K, 1/4 watt
L3: 5 1/2 turns 24SWG on T-50-2 toroid	R27,29: 1 Meg, 1/4 watt
L4,5: 12 1/2 turns 24SWG on T-50-2 toroid	R33: 1 Meg pot
L6a: 3 1/2 turns 24SWG on T-50-2 toroid, over L6b	R34: 1.2K, 1/4 watt
L6b: 35 1/2 turns 24SWG on T-50-2 toroid	R25,28: 360K, 1/4 watt
	RFC1: 100uH choke
	RFC2: 24uH choke
	S1: SPDT mini toggle switch
	S2: 1 pole, 3 way, rotary switch
	IC1-4: LM307 op amps (or 741)
	Vrac: Varactor diode, 3-34pF
	Z1: Zener diode, 8.2 volt, 1/4 watt



# The TMX 10MHz Transceiver

Thom Davis K8IF

21

The 10MHz band looks both interesting and promising. Conveniently placed between 20 and 40 metres, its propagation characteristics are attractive, (and the extra operating room with this new band is welcome too!). Its advent gives us a chance to do some experimenting and homebrewing as well. With that in mind, the TMX (Thirty Metre Transceiver) was developed.

The TMX is a VFO controlled CW transceiver that puts out about 2.5 watts. The receiver section is a direct conversion design with audio filtering and receiver incremental tuning (RIT). Break-in operation is also included.

A JFET VFO similar to the one in the July "ORP Quarterly" lies at the heart of this rig. I merely changed the LC constants at L1 and C2 & 3 for 10.1 to 10.15MHz operation. The VFO is always energised, providing injection to the product detector (TR7) and enhancing frequency stability. The VFO output is amplified by TR3 to drive the final transistor (TR4) to about 2.5 watts output.

TR3 is keyed during transmit, so is TR5 which opens antenna relay RLA1 and removes the antenna from the product detector input (L6a). RLA1 is a surplus reed relay (normally open), which has an adequate switching time for QSK. However, one may wish to use a diode QSK system instead, with a slight sacrifice in receiver sensitivity. The choice is yours. TR4 is an MPSU-31, which was purchased at a local hamfest for about 50¢. The ECG 322 version works just as well but may cost a little more.

The output of the transmitter section is run through a half wave filter consisting of L4 & 5, C20, 21 & 22. The filter provides better than 40dB attenuation of the second and subsequent harmonics (see Fig 3). The values for C20 and C22 were achieved by paralleling two 150pF silver mica capacitors. C21 consists of a 100pF and a 500pF capacitor wired in parallel. The windings on L4 and L5 were spread equally over each of the cores for maximum output. TR4 output matching is achieved with a pi-network, 36 to 50 ohms impedance, consisting of C18, L3 and C19. The windings on L3 occupy about one third of the T-50-2 core.

In the TMX's early stages of development, an MC1496 IC was used as the product detector, but I encountered several problems, such as AM detection. The change to the 3N204 dual gate Mosfet improved the rig's performance overall. With the addition of audio filtering and the use of low noise operational amps (LM307), the receiver's sensitivity is about 1.5 microvolts (10dB S N D/N). IC1 is the preamp, following TR7, and has a gain of about 65dB. IC2 and IC3 make up the active audio filter which was designed for a centre frequency of 750Hz and bandwidths of 150Hz and 110Hz. IC4 is the output amplifier with a gain of about 3.8dB and it drives high impedance headphones. S2 selects the desired filter bandwidth.

The RIT section was not part of the original project, but its simplicity and enhancement of performance make it a welcome addition to the TMX. During receive, R12 can be used to offset the receive frequency plus or minus a few KHz. Changes in the control voltage at R12's wiper cause changes in capacitance in the varactor diode. The amount of this change can be limited by the setting of C4. I have set mine for plus or minus 2.5KHz. During transmit, D1 is grounded, causing a predetermined voltage at R12. This voltage is set by R13. In my alignment, the voltage is set at 4v, which represents the centre frequency of the RIT range.

Alignment of the TMX is as follows:- Bring the VFO into range by monitoring its output on a receiver, or by using a frequency counter, coupled to the base of TR3

through a 0.1mfd capacitor. Set C3 to maximum capacitance and C2 to about half its tuning range. Preset the core of L1 about halfway inside the former and turn the unit on (but do not key). Adjust L1 slowly up and down, listening or watching the counter for 10.100MHz. Then adjust C3 for maximum capacitance, and check your frequency. If higher than 10.15MHz, then reduce the capacitance of C2 and repeat. This procedure is repeated until the frequency span is about 50KHz. This will set the frequency coverage of the TMX.

Next, connect a 50 ohm load to the antenna socket, along with a power meter capable of measuring about three watts. Preset the core of L2 to about half way down the coil former and, removing the frequency counter (if used), briefly key the rig. While monitoring the output, adjust the core of L2 for maximum power output. Be sure to keep the key down for short periods only if you do not want to roast the final transistor! Next "tweak" L3, by compressing or expanding its turns, for maximum output. Repeak L2 and repeat the procedure for maximum output - about 2.5 to 2.8 watts.

To adjust the RIT control, measure the voltage at the junction of R11 and C23, with R12 set at its mechanical centre. Adjust R13 for four volts. This approximately sets the centre frequency of the RIT control. Key the transmit section and measure the voltage again (while keyed). Record the reading, unkey the transmitter and turn R12 until the keyed and unkeyed voltages match. Key the transmitter again and adjust R13 for four volts at the wiper of R12. Mark this setting on the chassis or record the knob setting, because this is your zero beat frequency. Unkey the transmitter and turn R12 to both extremes. Voltages should be 1.7 (minus offset) and 6.5 (plus offset). C4 sets the amount of RIT swing, determining how far plus or minus the centre frequency you can go, i.e. plus or minus 1KHz, 2KHz, etc. Return the RIT control to zero beat frequency, your recorded centre setting, for matching the receive and transmit frequencies.

The receiver can now be peaked, either with a signal generator or an on-the-air signal. Set S2 to the maximum bandwidth position (bypassing IC2 and IC3). Disconnect the 50 ohm load and replace it with an antenna or a signal generator set for a five or ten microvolt level. Plug in the headphones and set the volume control (R33) to about half its range. Turn the main tuning capacitor to 10.100MHz and peak C24 for maximum audio level when receiving the signal generator or the on-the-air signal. Don't fret if you do not have access to a signal generator, I have peaked the rig on RTTY signals at 10.130MHz and came very close to the results of a laboratory alignment! Next, check the RIT. Set R12 to centre and zero beat a signal. Slowly turn R12 to both extremes. The audio pitch at each extreme should be about the same. If you pass the frequency response of your ears at either end of the range of R12, C4 may be set too high, making the offset greater than plus or minus 3KHz approx. You can narrow the swing by reducing the capacitance of C4 but, because this will affect the VFO calibration, L1 will also have to be retuned. C4 could be replaced with a fixed value capacitor from 3pF to 10pF. The higher capacitance results in a wider RIT swing.

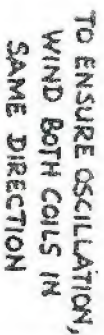
Finally check the audio filtering of IC2 and IC3. Tune a signal at about 1KHz with S2 at its first position (widest bandwidth). Turn S2 to the second position. The audio should drop about 4dB and should drop about 10dB in the third switch position. The filter bandwidth is 150KHz (second position) and 110KHz (third position).

This completes the alignment of the TMX and now you should be QRV! The entire project was bread-boarded, so no PCB information is available. Anyone who builds the TMX on a PCB may be willing to let the Club know and supply the etching pattern. Further, any modifications would be welcome, i.e. sidetone, diode switching, metering, etc. Good luck and hope to see you on thirty metres.



W9SCH

C. F. ROCKEY  
C-QRP-C-091



## Complete ONE TUBE Amateur Station. C.F. Rockey W9SCH

For those of you who long for simplicity, here is a suggestion. One could hardly think of a simpler practical set-up.

Don't laugh; those of us who have used one extensively in former times can testify first hand to the sensitivity and selectivity of a carefully built and operated regenerative detector. Young fellows brought up in this tinselled age may be in for a surprise when they try one, after all, when set "on the edge" of oscillation, a single valve with positive feed-back can easily realise a voltage gain of thousands in practice. (Ask any old timer the number of VK and ZL stations he has copied with one back in the 30s - good ideas are slow-a-dying!).

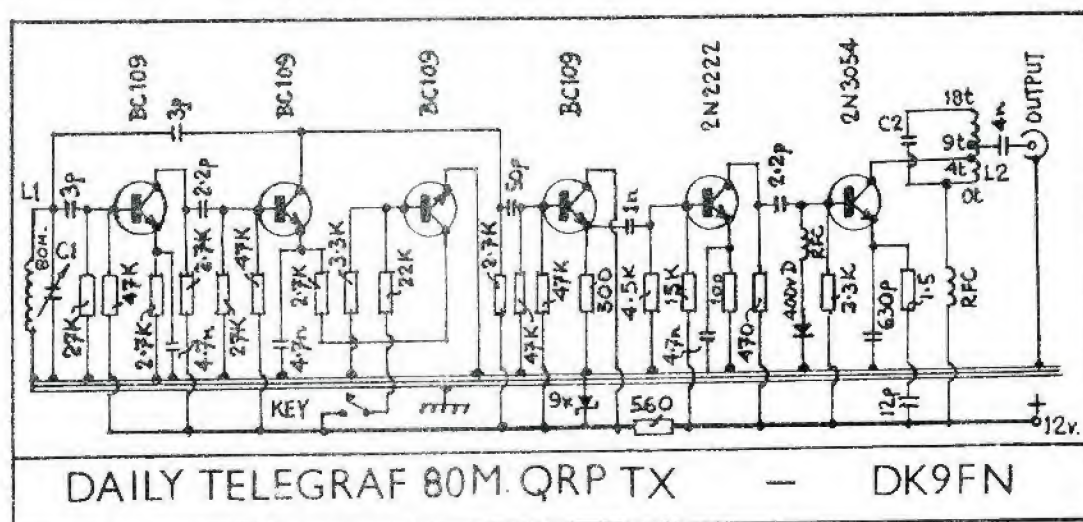
One half of any double triode can run nicely on CW at 100 volts and 20mA. This is 2 watts input and any active QRP'er knows what can be done with 2 watts input and a good antenna.

One of the genuine deficiencies of the regenerative receiver is its poor strong signal handling capacity. As a result, one cannot "spot" one's own transmitting frequency normally when using one. This precludes the use of a VFO in this set-up, so the transmitter must be crystal controlled.

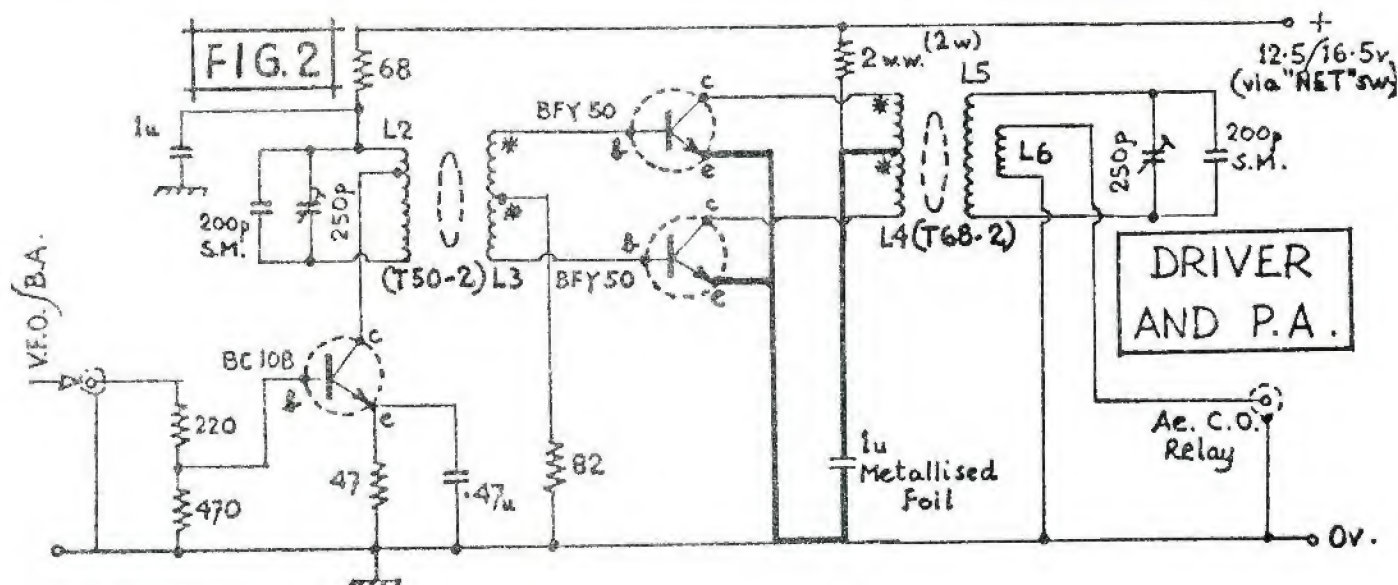
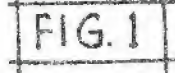
Please remember that the circuit diagram is just a suggestion. Feel free to modify it in detail, as your taste or experience justify. (No good radio man ever follows a description literally anyway, rather he uses it as a stimulus for his own thought, using the parts at hand; so it should be in this case).

The electronically boisterous condition of the amateur bands in the U.S.A. precludes success with crystal controlled QRP here (we have tried it and it is "bad news"). Therefore we hope that either someone in the U.K. or Europe (where the bands are more tranquil, we trust) will try a rig of this sort and report on his success. To try such a rig in the U.S.A is to ask for a case of frustrated fidgets, or worse!

For a tuned circuit inductor suitable for either transmitter or receiver, use SWG 20 to 24, close wound on 1½ inches (3.2 cm) former, as in the diagram. For the receiver, start out with a plate tickler coil of about one third of the tuned circuit turns and remove for smoothest regeneration control and best signal strength. The antenna coil may be one turn for the 20, 40 and 80 metre bands, say five turns for 160 metres. Keep the antenna coupling loose for best stability and freedom from strong signal blocking. Adjust individually for best performance. For the transmitter, one or two turns around the "cold" end of the tank coil should suffice for antenna coupling. Adjust individually for best keying and output.





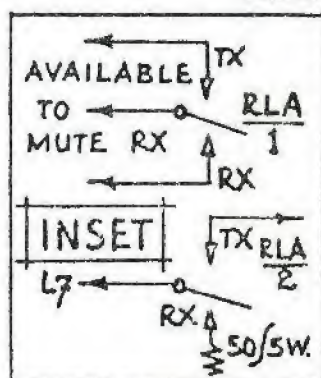
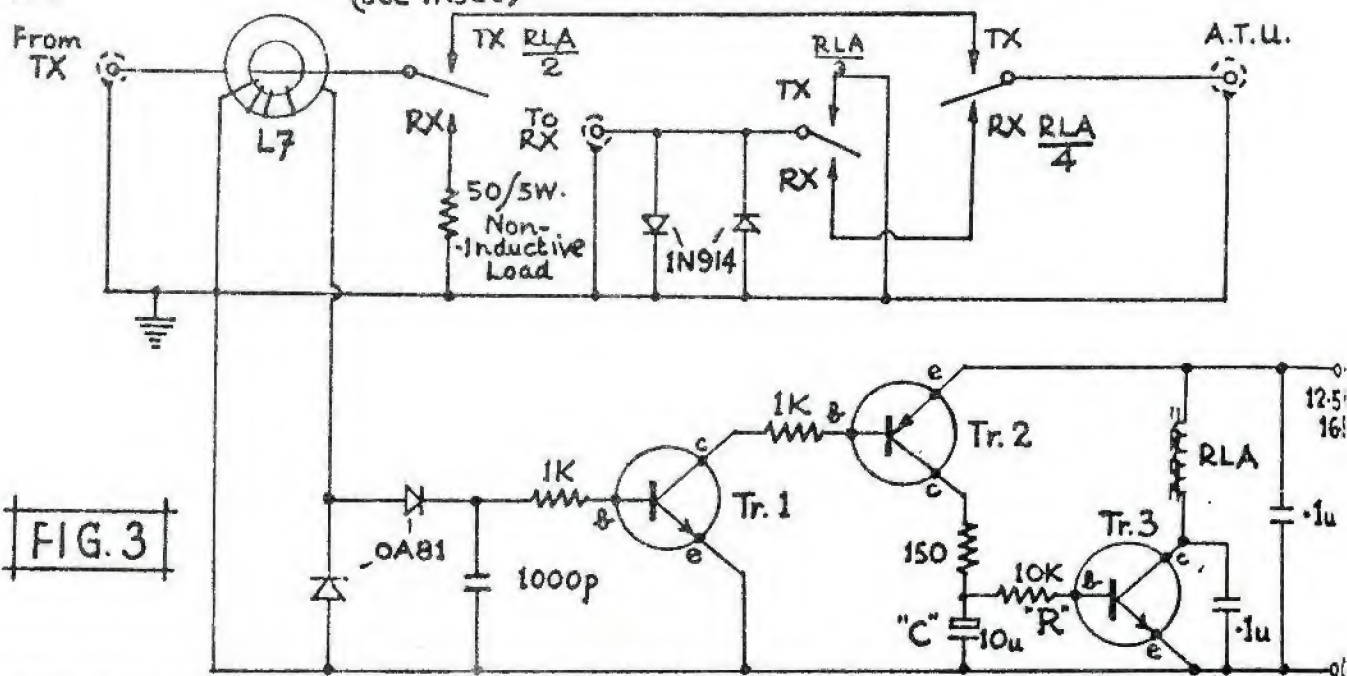




L1 - 38 turns, 28SWG, on T50-2 toroid former  
L2 - 35 turns, 28SWG, tap at 9 turns from "HT" end, on T50-2 toroid  
L3 - 6 + 6 turns, 28SWG, bifilar wound over centre of L2  
L4 - 4 + 4 turns, 28SWG, bifilar wound over centre of L5  
L5 - 35 turns, 22SWG, wound to fill a T68-2 toroid  
L6 - 5 turns, 22SWG, wound over top of L4  
(Start of windings indicated by asterisks \*)  
Tune L2, L3 for max output at 3.53MHz; L4, L5, L6 for max output at 3.57MHz.

Note - BC108 and both BFY50s fitted with clip-type heat-sinks

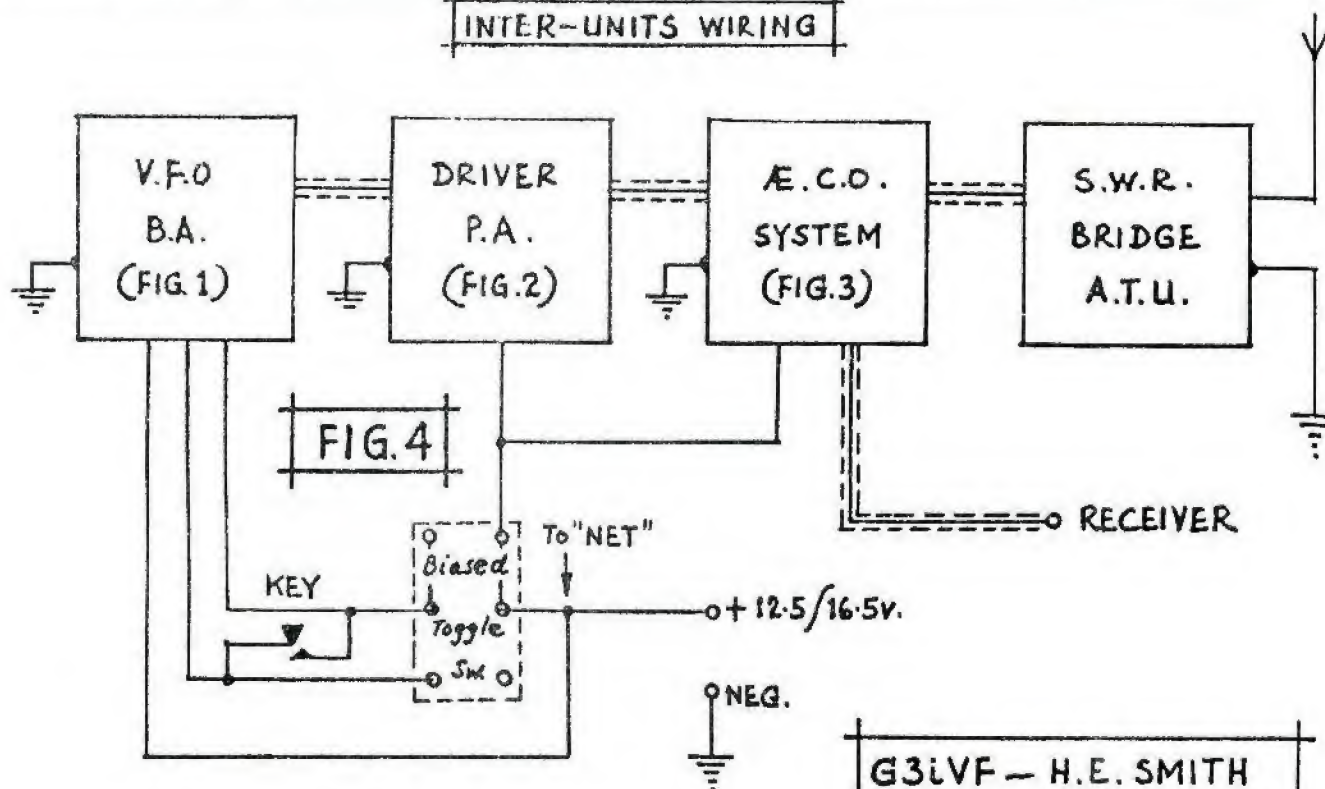
## R.F.-POWERED A.E. CHANGE-OVER SYSTEM

(see inset)



- RLA = 12v. 4p. C.O. Relay
- Tr1,3 = Any silicon NPN transistors
- Tr2 =  PNP 
- L7 = 8t. on any small toroidal core, then slipped over coaxial inner.
- "C"/"R" = Values given allow system to revert to Receive, between words, at 15 < 20 w.p.m.  
Drop-out time can be changed by varying the time-constant of "C" and "R".

## INTER-UNITS WIRING



G3LVF - H.E. SMITH  
 — G-QRP-C, 164



In 1976 G3IVF was bitten by the QRP bug and at the same time decided to get away from the "black box brigade" who were invading the VHF bands. Previous 80m operation was immediately after being licenced, some 25 years ago. In those days the first twelve months on the air had to be spent on CW with 25 watts maximum input - and at that time G3IVF did not like CW! So during this period, success was minimal, the best distance worked being DL and OZ. The challenge was thus: could what had not been done 25 years ago with 25 watts of CW now be achieved using QRP CW?

The first QRP TX was crystal controlled at about 450mW. Its first QSO was with G2HLL in Leeds, which rather helped the G3IVF ego! The input was upped to one watt and QSOs over greater distances resulted, but by this time it was becoming very obvious that crystal control and QRP do not mix - not for G3IVF at least! (or for the rest of us! Ed.)

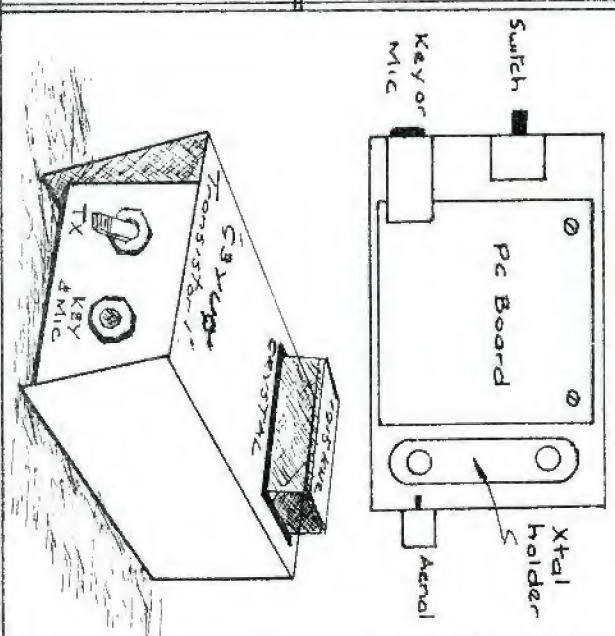
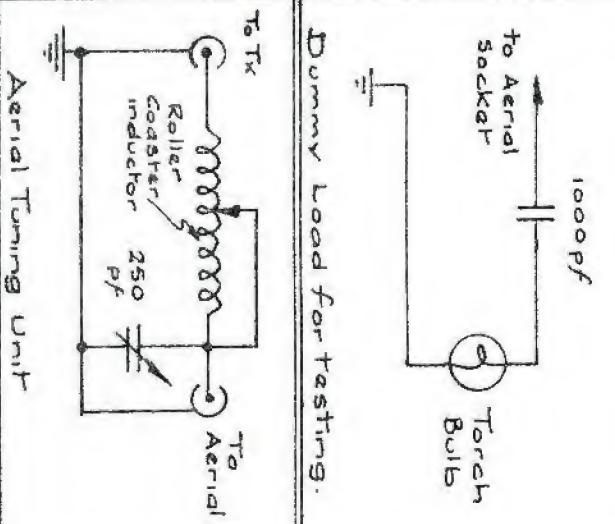
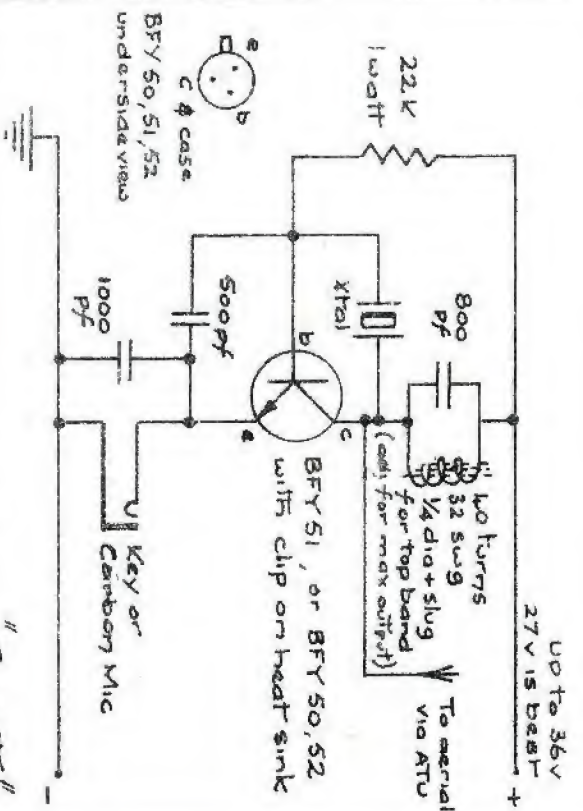
Rig No.3 was then constructed, using a VFO/BA/Driver/PP PA circuit. Things immediately began to happen, good reports being received from as far away as DM when using a 90ft. aerial about 10ft. high, even though operating time was very limited.

Further improvements to the VFO were indicated, and they were achieved by using the Tesla (Vackar) circuit with the correct ratio of series-capacitor to swamp-capacitor (Fig 1). The results have been outstanding: the VFO is so stable it sounds like a crystal and it keys well also. Many of the stations contacted have asked for details.

Modifications were then made to the aerial and earth systems. The aerial length was increased to 150ft. and the height at one end to 25ft. (the other end is still at 10ft.) Taking a tip from G8PG, all the local barbed wire was bonded together and connected to the earth system. The new radiator is used with a 3W PP PA (Fig 2) which is broad-banded over the range 3.5 to 3.6MHz, and has an efficiency of around 66%. To provide automatic changeover from send to receive, a system described in "Wireless World" was tried but it proved to be a transistor "zapper". It was then modified to the circuit shown in Fig 3, which works perfectly. The final set-up is now as shown in Fig 4. Whether it has fully met the challenge outlined above, G3IVF does not know, but he has enjoyed every minute of the project, has greatly increased his morse proficiency, and has worked 21 countries on 80m with QRP - none of which can be bad! His next project is a direct conversion receiver. (SPRAT article, please. Ed.)

### Constructional Notes on Fig.s 1, 2 and 3.

1. Mount the VFO frequency determining components very rigidly.
2. Build the VFO in a die-cast box with a lid and decouple the key and DC leads.
3. Use single-point earthing for the VFO components - it really is significant.
4. RF drive to the Driver can be varied by changing the ratio of the 220/470 ohm potential divider in the base-emitter circuit. If the resistors are replaced with a 1K pot, it can be used as a variable power reduction facility.
5. Earth the PA transistor emitters and the output coil centre-tap capacitor to the same point, via short leads.
6. Use good quality silver mica, polystyrene and metallised foil capacitors where indicated on the diagrams. All other capacitors can be ceramic.
7. The VFO/BA circuit was built on a PCB. The other circuits were built on "Lektrokit" (equivalent to plain Veroboard).
8. The power supply can be either a suitable 12v rechargeable battery, or a stabilised mains power unit. When the key is pressed PA current rises to 250mA.



# NOTES

TESTING - Connect 9 to 27v supply, morse key & dummy load. Press key and adjust coil slug for max output.

OPERATION - Connect 9 to 27v supply, morse key and aerial via ATU. Press key & adjust ATU for maximum output on a Field Strength Meter.

Note: If loading is too heavy, TX will stop oscillating. Best point is just below this.

For AM - Connect a carbon mike in the jack socket. Note: Mike must be carbon. Output is about 1/2 of CW output and modulation is "downward". However I still get very good results up to 15 miles on AM with 90 ft. end-fed wire and a fair earth.

POWER SUPPLY - I use 3 x PP9 batteries in series to give 27v but TX will work OK with only 9v, i.e. 1 x PP9 (the smaller PP3 type are not suitable).

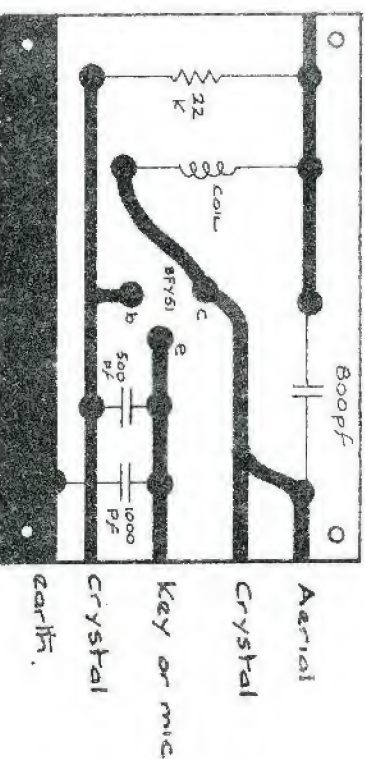
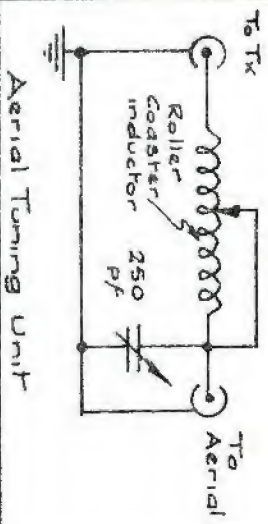
POWER OUTPUT - This varies a little with different transistors but the average is as follows:-

9v gives 1/2 watt AM, 27v gives 1/2 watt AM. (for CW, double these)

USE ON OTHER BANDS - AM not really suitable due to extensive use of SSB. CW should give good results. A change of crystal & coil is all that would be required.

CRYSTALS - 10X (or any large type) are best.

P.C.B. - Not essential but produces a better job.



"Printed circuit board."

copper side

"Transistor 1" Simple AM/CW 160 meters Transmitter. Designed by G3YUQ



Repeaters are one of the most advanced developments in amateur radio (in contrast with the operating procedure of some users). If you live close to a repeater or can travel to a repeater site, expensive FM equipment is not needed. All the sophistication is in the repeater, so only a simple up/down link is required. The repeater can be received and accessed by very simple home-brew circuits and communication can be established throughout the repeater area.

The idea came to the author while working close to the Munich City repeater. It could be received easily on an ancient valve receiver. What would be the simplest circuit needed to access it?

A crystal of about  $1/15$  of the repeater input frequency was found in the junk box and an oscillator built around it. The crystal was excited between base, emitter and ground of a 2N918, and the 15th harmonic was filtered out in the collector circuit and fed to a simple  $\frac{1}{4}$  wave wire antenna. The circuit was the same as Fig 1, but the 2N918 was used for T1 first and the 145MHz output filter was connected instead of that for 48.3MHz. The output measured at 145MHz was  $5\mu\text{W}$ . Suppression of the 14th and 16th harmonics was only about 10dB, but this was no problem because  $25\mu\text{W}$  is the limit of unwanted harmonic power in Germany for VHF amateur equipment.

The crystal oscillator was directly frequency modulated by capacitance diodes. As the voltage swing at the hottest point (H) was about 10v, four diodes were needed to pull the frequency plus or minus  $5\text{KHz} \div 15$  (= plus or minus 333KHz). To check this, a frequency counter was connected to the oscillator and the frequency shifted by turning potentiometer R1 through its range. The swing needed was plus or minus 5v, not quite symmetrical because of the pulling characteristics of the crystal.

As a cheap crystal mike was to be used, a two stage AF amplifier was built to modulate the oscillator. T3 is a junction FET to provide a high input impedance for the mike, and T4 operates as a limiting amplifier at 10 Vss output. The harmonics produced by the limiting action are attenuated in a two stage RC low pass filter, and the AF voltage is fed to point P, the DC voltage of which must be adjusted to the middle of the pulling range (about +5v). The coupling capacitor (of 2.2 to 4.7nF) suppresses the low speech frequencies for good readability. The value depends on the operator's voice characteristics. Limiting the speech amplitude and the FM deviation is highly recommended to avoid distortion at the receiving end. Also, many repeaters have a deviation control which shuts down on receipt of excessively deviated signals. Because of the limiting action of the AF amplifier and the operating point of the capacitance diodes, the 12v supply should be stable.

Using this  $5\mu\text{W}$  single stage transmitter, the repeater could be accessed from a distance of several hundred metres, and of course many repeater users were astonished about the low power level. Stations throughout the repeater area were worked, also some special sites in the Bavarian Alps, via mountain reflections.

The repeater aerial was subsequently moved (to improve coverage in the northern part of Munich). After this it became difficult to access the repeater from the same room with  $5\mu\text{W}$  so the author decided to split up the frequency generation and build a two stage transmitter. The 2N918 in the oscillator was replaced by a BC108 and the 2N918 used as a frequency multiplier.

First, the crystal frequency was tripled to 29MHz in the oscillator output, then quintupled to 145MHz in the 2N918, resulting in an output of  $350\mu\text{W}$ . However, the tripler output at the oscillator collector was so high that the transistor saturated and there were two peaks when tuning L1 for best output. The emitter resistor therefore had to be increased to avoid saturation and to obtain a single tuning peak. Unfortunately, this changed the frequency modulation conditions too.

As the reduction of oscillator current meant a power loss, the frequency multiplication scheme was changed to  $\times 5$ ,  $\times 3$ . The oscillator output was tuned to 48.3MHz and tripled to 145MHz. R2 could be decreased to 1.2K again, the modulation characteristics were as before and the 145MHz output was 2mW. Suppression of unwanted crystal harmonics was at least 35dB, so harmonic power was still well within the 25 $\mu$ W limit for Germany. Fig 2 shows the final circuit.

With 2mW output it was also possible to access the repeater from the home QTH over a distance of about 15Km across the city of Munich (but safely only at night when the channel was really clear). The home aerial was a 120cm vertical wire in the roof, about 9 metres above ground, matched to 60 ohms by a matching section (Fig 2).

To access the repeater by tone, T4 was bridged by a double T network, adjusted to 1750Hz by R3. The resistors at the inputs of T3 & T4 (1K and 560 ohms) are to prevent VHF oscillation. Also, as a countermeasure against speech time limitation, a 555 timer IC has been added, which inserts a break of 1.5 seconds into the transmission. The first time 60 seconds after beginning, then every 45 seconds (at the beginning, charging of the timing capacitor starts from zero volts, not from  $\frac{1}{2}$  of supply voltage as is usual with this IC). During the interruption of the FM carrier, the LED is lit to show which part of the speech should be repeated.

Reproduction of this circuit depends on the availability of a suitable crystal. Excitation in the fundamental mode is recommended to achieve good modulation characteristics. A wide variety of crystal frequencies and multiplication schemes exist, including cheap CB crystals (channels 19 to 23 for repeater input) in the fundamental mode (see table). First, the oscillator must be pulled to a sub-harmonic of the desired repeater input frequency (if required, use a series coil to increase the pulling range). After this, the deviation range should be checked by varying R1 and possibly the number of capacitance diodes. The frequency multiplication must be checked with an absorption frequency meter or a good counter to avoid output on the wrong harmonic. The limited AF output of T4 is determined by the difference between the supply voltage (+12v) and the voltage drop at the emitter resistor (2v), which is dependant on the base divider voltage. The collector must be at mid potential between the emitter and the supply voltage (+7v). If the capacitance diode combination requires less than 10v p-p for plus or minus 5KHz deviation, the modulating voltage, after limiting, can be reduced by the deviation control potentiometer.

#### Simplest FM Receiver

After the transmitter problem had been solved, the next question was; what is the simplest circuit to receive a nearby FM station? All the popular FM ICs would require a super-heterodyne circuit. For instance, the transmitter carrier could also be used on receive, to mix the repeater output frequency to an IF of 600KHz, where an IC could be used.

However, the simplest kind of receiver for this purpose was found to be a special version of the author's shortwave FET regenerative receiver (SPRAT - Autumn 1975 and Spring 1976) operating as a slope detector just before regeneration occurs (no regeneration = no radiation). The detector circuit is shown in Fig 3. A two stage AF amplifier is needed for headphone reception, as in the 1975 circuit (2 x BC108).

For good mechanical stability of the VHF circuitry, a small PCB was etched. To avoid any hand-capacity effects, both tuning and regeneration are controlled by capacitance diodes, as in the 1976 circuit. An Amidon toroidal coil was used even at VHF because the influence of nearby components on resonance is much less and coupling between coil sections L and Lr is much better and improves regeneration.



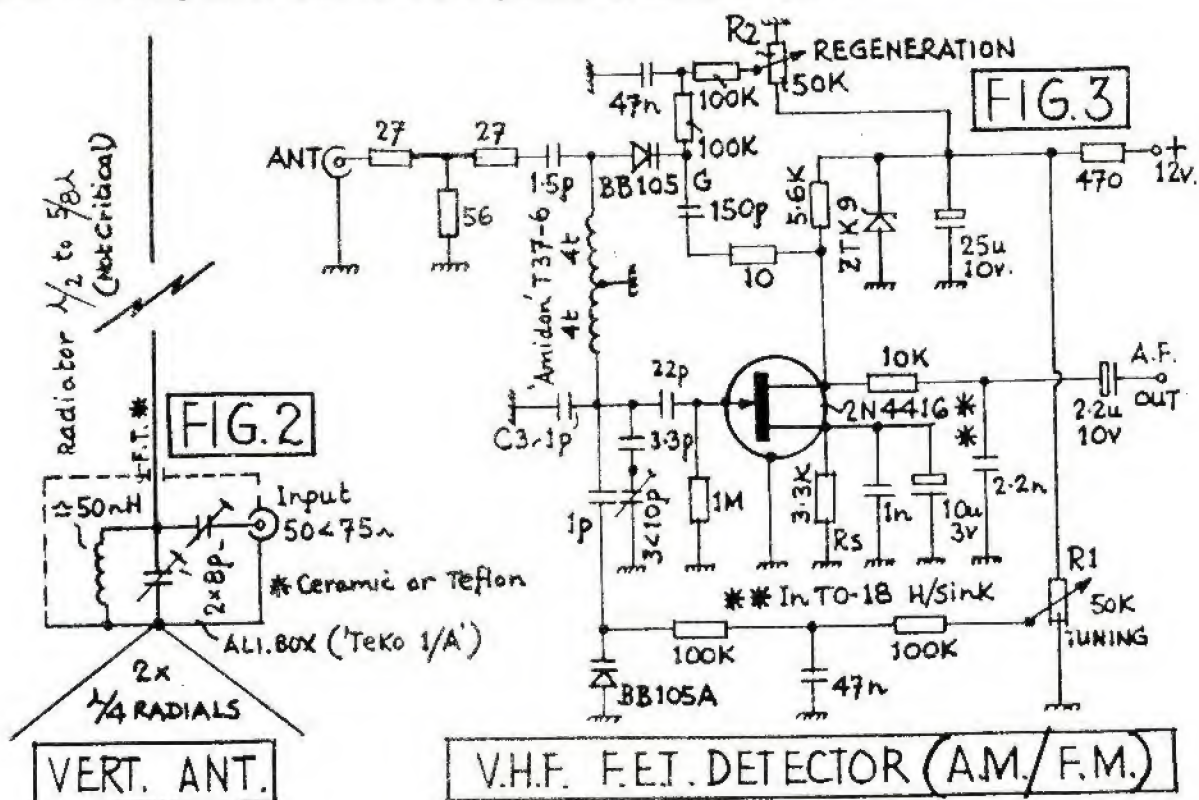
The optimum values of resistors  $R_s$  and  $R_d$  depend upon the FET characteristics which may vary considerably even within a specified type.

$R_s$  is replaced by a 5K and  $R_d$  by a 10K pre-set, and both are adjusted first so that the FET does not saturate ( $V_{DS}$  about 2 to 3 volts). Next, the regeneration is made operative and the tuning checked by an amplitude modulated VHF signal generator. It may be necessary to vary the number of coil turns and/or to add a small capacitor  $C_3$  to make the circuit resonate at about 145MHz with trimmer  $C_1$ , with the regeneration operating within the range of potentiometer  $R_2$ . Then  $R_s$  and  $R_d$  are varied for best detector sensitivity combined with good regeneration performance. The resistance values obtained are measured and the pre-sets replaced by fixed resistors. Finally,  $C_2$  is checked for a total tuning range of about 1MHz, or somewhat less, over the range of potentiometer  $R_1$ . Both potentiometers should be large diameter types for good linearity.

A prototype of this detector, using trimmer capacitors and slug tuning, was tested close to the Munich repeater. Reception was sufficient but adjustment was very critical. With the diode version however, adjustment was so fine that the Munich City repeater could be received at the home QTH. The Zugspitze repeater on West Germany's highest mountain, on the next channel only 25KHz away, could also be received and separated from the City repeater. This was much more than was expected and needed for use with the QRP transmitter.

Some temperature drift on both tuning and regeneration was noticed initially but was greatly reduced by two measures. The FET was cooled by a TO-18 heatsink (Wakefield NF201 or 203, or equivalent) in spite of the low DC power level. Also, better than average voltage stabilisation was needed, ordinary zener diodes or 78XX type stabilisers being inadequate. The  $\mu A723$  or improved versions of it are recommended, or the ITT ZTK9 stabiliser especially designed for voltage-tuned radio & TV circuits. Further experiments on this receiver will also evaluate capacitance tuned line circuits.

It is hoped that the circuits of Fig 1 & 3 will be especially interesting to the home-brewer, who does not like spending much on FM gear but who likes to experiment in spite of being different from the generally accepted view.



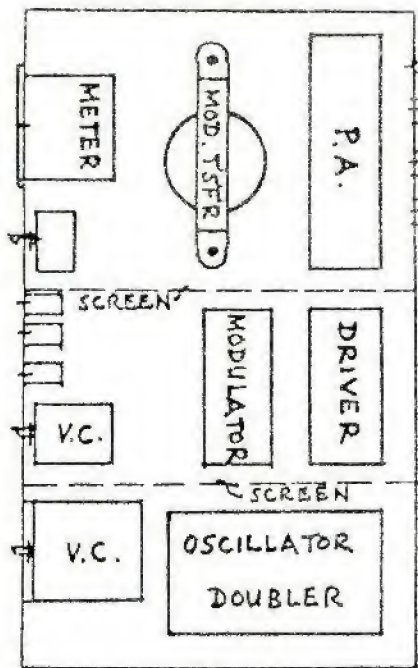
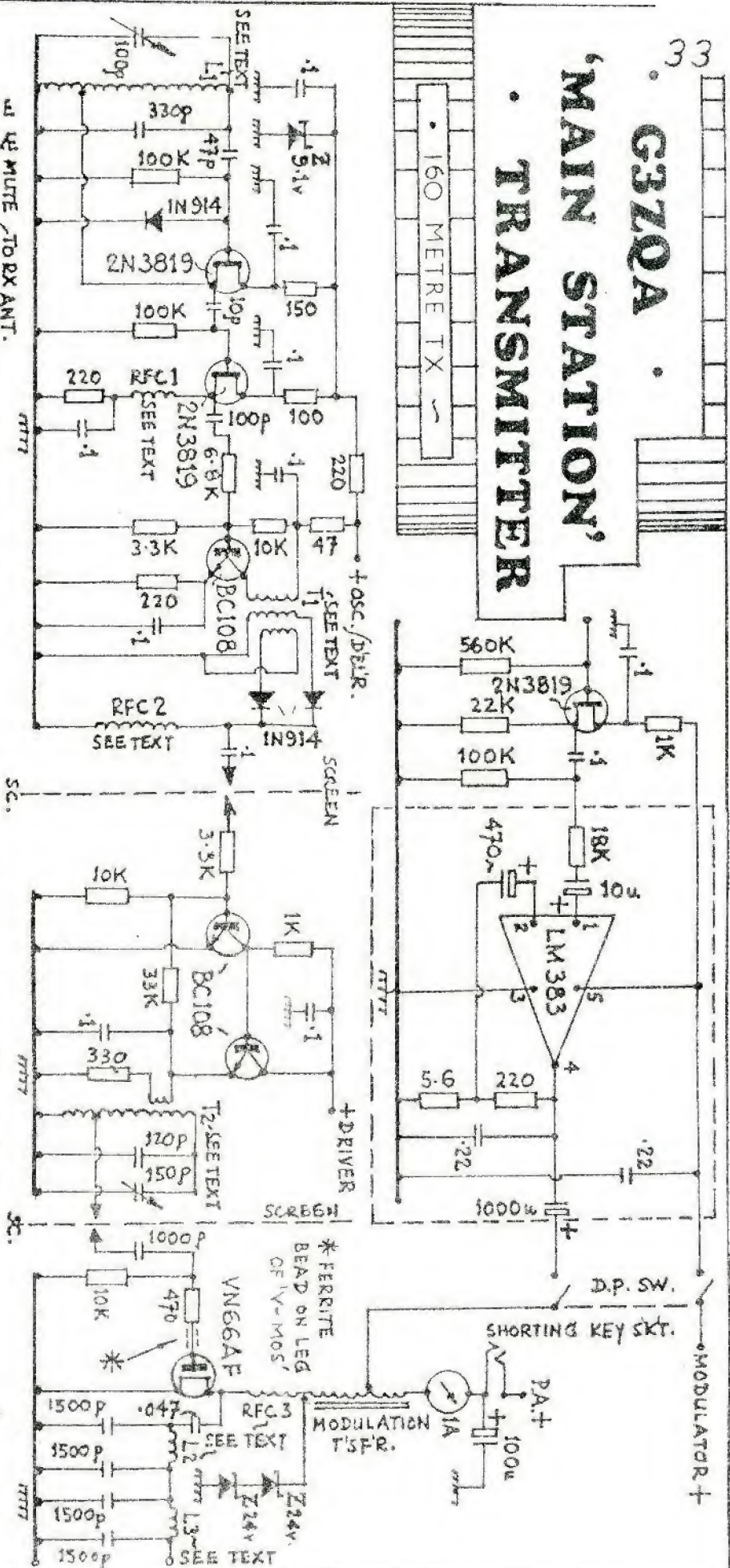


33

G3ZQA

# 'MAIN STATION' TRANSMITTER

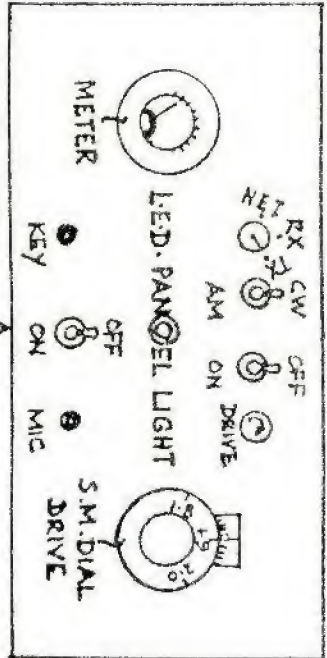
160 METRE TX



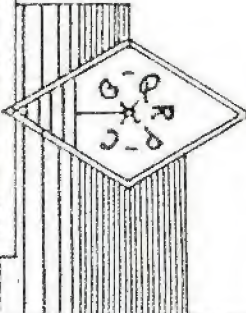
PLAN

SUGGESTED LAYOUT  
NOT TO SCALE

PANEL



ROY ROWANTREE  
- G3ZQA -  
GQRRC/NO.170





## 160M Main Station VMOS Transmitter G3ZQA

The three transmitter sections are built on Veroboard and the modulator on the PCB in the kit, mounted upright with the FET pre-amp on a small piece of Veroboard attached to one of the securing bolts. When winding toroids, slide the toroid to the centre of the piece of wire being used and wind in two halves. For L1 wind 45 turns, turn it over and wind 45 turns with the other wire. The toroid is then full, so a tap is made and a further 17 turns wound over the winding just completed, this end then forming the earth end. T2 is wound with 15 turns, a tap is then made and a further 20 turns wound, turn it over and fill the toroid with the second wire (about 33-35 turns). The link is wound over this with plastic covered wire.

Polystyrene capacitors are preferred in the oscillator and 0.1mfd disc ceramics for decoupling. The modulator is an 8 watt amplifier kit from Maplin (Rayleigh, Essex, UK), based on the LM383 with the addition of an FET source-follower pre-amp. No volume control was found to be necessary. The output capacitor in the kit is connected in reverse polarity to that shown on the PCB and a 100K resistor is connected across the input terminals to check possible instability. The dotted square on the circuit diagram indicates the Maplin kit components.

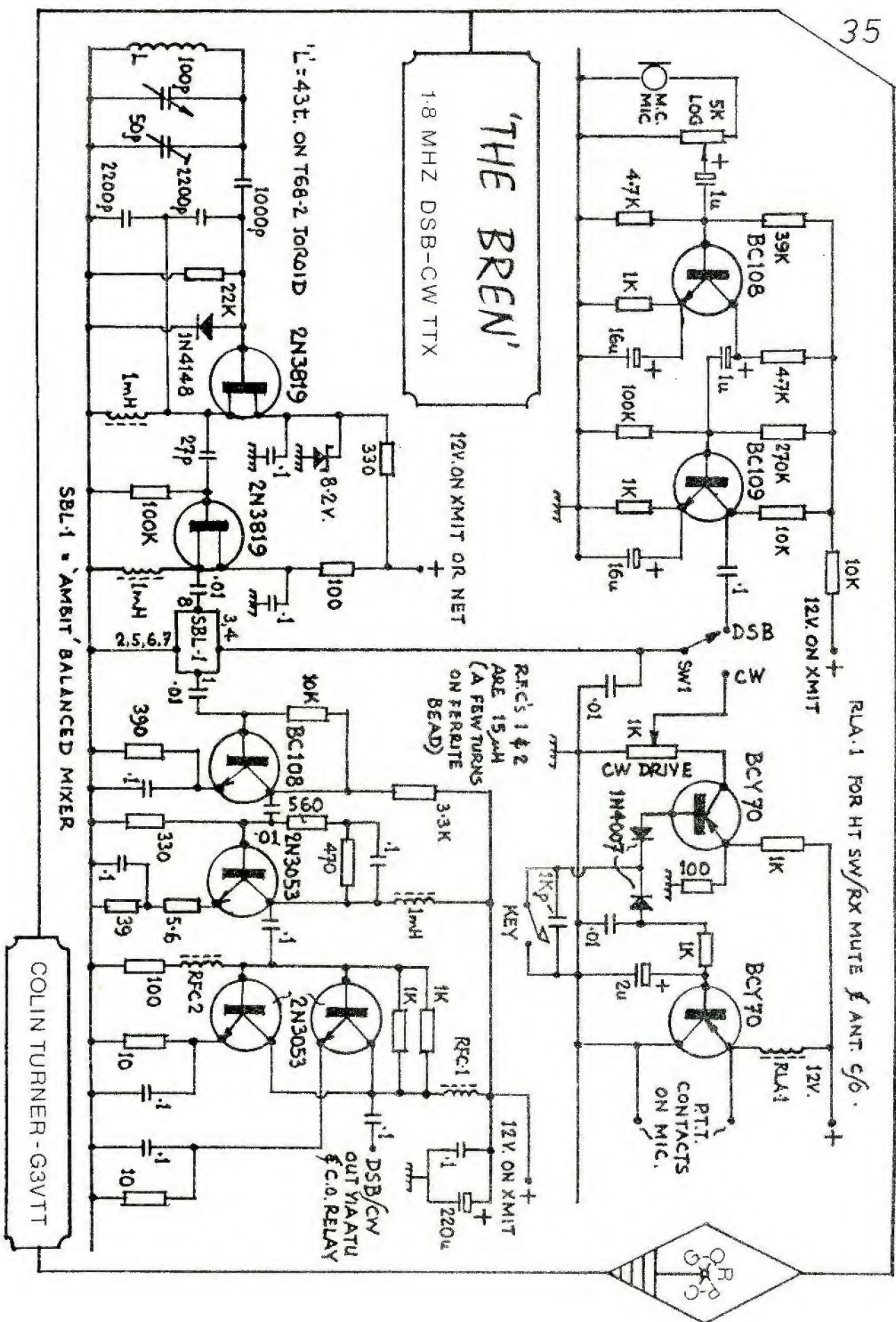
The modulation transformer is made from a valve type output transformer with about a  $\frac{1}{2}$ " square core and the windings on a bobbin. The laminations are removed and all windings taken off the bobbin. Then four layers of 20/22 SWG are wound on, a tap made and a further two layers wound. The start of the winding (at the centre) goes to the PA and the outside to the power supply, (about 25-30 turns per layer, depending upon the gauge of wire, but the number does not appear to be critical). A separate earth lead is taken from each of the four sections to a common point on the chassis, to which the power supply negative is connected.

The VMOS is a high frequency device and readily goes into spurious VHF oscillation if leads are not kept short and the layout doesn't follow good practice. In developing this circuit, several VMOS were blown, due apparently to two main causes: (1) overdriving and (2) destructive modulation transformer surges which seem to occur under certain conditions. To prevent damage from (2) zener diodes are connected from the modulation transformer to ground and for (1) a satisfactory drive level is indicated when, with a dummy load of 25 ohms connected to the output, about 450mA at 12v supply is drawn by the PA. The drive level can be adjusted by altering the value of the 3K3 series resistor to the base of the first transistor of the feedback pair, but three transmitters have now been built to the circuit shown and all behave satisfactorily. The transmitter works well into an aerial/earth input impedance of about 25 ohms and shows an efficiency of over 60% when measured with a simple output meter similar to those described recently in "SPRAT".

The switching is arranged so that on net, the driver can be put in or out of circuit to vary the strength of the netting signal, to cope with both strong local signals (driver in), and weak signals (driver out). The AM/CW switch cuts the modulator out of circuit, the modulation transformer and 100mfd capacitor then forming an effective key shaping network. The receiver is muted on transmit.

### Coil Data

- L1 - 107 turns, 30 SWG on T68-2 toroid tapped 17 turns from earth end.
- T1 - 15 trifilar turns, 30 SWG on Ft37-61 ferrite toroid (3 wires twisted, about 10 turns per inch)
- T2 - 68 turns, 28 SWG on T68-2 toroid tapped 20 turns from earth end. Link 7 turns evenly spaced.
- RFC1 - 1mH. RFC2 - 11 turns, 24 SWG through small ferrite bead. RFC3 - 100µH
- L2 & L3 - 27 turns, 22 SWG on T68-2 toroids.





## The BREN 160M DSB/CW Transmitter G3VTT

For the last few years I have kept, or tried to keep, a regular sked on 160 metres with G2HKU and PA0PN every Sunday morning. With the decision to go 100% QRP and the selling of the Far Eastern Tin Box 101, I was stuck with the need to get a couple of watts of phone and CW energy on 1832KHz.

Although the previous transverter had been transistorised, I decided I wanted to try out a few ideas on the theme of DSB and CW. I am using a Drake 2C receiver along with the receiver section of the transverter described in "SPRAT" a couple of issues ago. The transmitter, which I call the BREN, works fairly well and has been used by our illustrious guvnor, G3RJV on his last summer visit to this corner of the Island.

The VFO - The VFO is stolen from the QRP Bible (Solid State Design for the Radio Amateur from ARRL which, of course, you will all have a copy of!). I built the VFO in an Eddystone diecast box using solder-tags, tagstrips and a tagboard. I also built the SBL1 balanced mixer into the same box using a small strip of Veroboard. I recommend that the VFO and Mixer are built together to stop "carrier" leakage, i.e. VFO output leaking past the Mixer, which will make your DSB sound like AM in a local receiver. A little attention to the usual VFO design criteria will ensure that the VFO is stable and re-settable ("driftitis" is NOT a problem with this design).

PA and Driver - The amplifier stages are in Class A and are along the lines of the excellent circuits recommended in the above-mentioned book. I have built this driver and PA using the most readily available parts, if in doubt consult the book but you will find all RFCs are 15 $\mu$ H. 2N3053 are used as they were available, the input power is about four watts and measured output power is two watts on CW.

CW operation - Having been spoilt by using a Ten-Tec Argonaut for the last few years, I decided to try to get full QSK. This has nearly been achieved by the circuit shown, which has a 2mfd capacitor in the base circuit of the relay switching transistor to prevent "chatter" at high keying speeds. The relay is a normal continental 12 volt type which is used for antenna changeover, receiver muting, HT switching, plus a few contacts left over if I want to add and switch a further amplifier stage. CW output is achieved by the second transistor, they are both PNP, which puts DC into the SBL1 to unbalance it each time the key is pressed. The component values shown give fairly soft keying, which I prefer.

DSB - A simple two-stage microphone pre-amp gives ample gain to drive the SBL1, the gain control is normally at half gain. Switching to CW puts the AF input of the SBL1 to the DC voltage coming from the keying transistor.

RESULTS - No tank circuit is needed, I merely use the normal station ATU to give maximum RF output with minimum SWR. The first night's operating gave good reports around G-land on DSB and a CW QSO with OK1DLE at 559. Why call it "BREN"? Well, George has The SCD and the BEN (which my spies tell me has been developed for the new 10MHz band!), I decided to keep in with the wife by using the first four letters of her name. Needless to say, she is not amused. Anyway, why not try a bit of DSB on 160 metres?

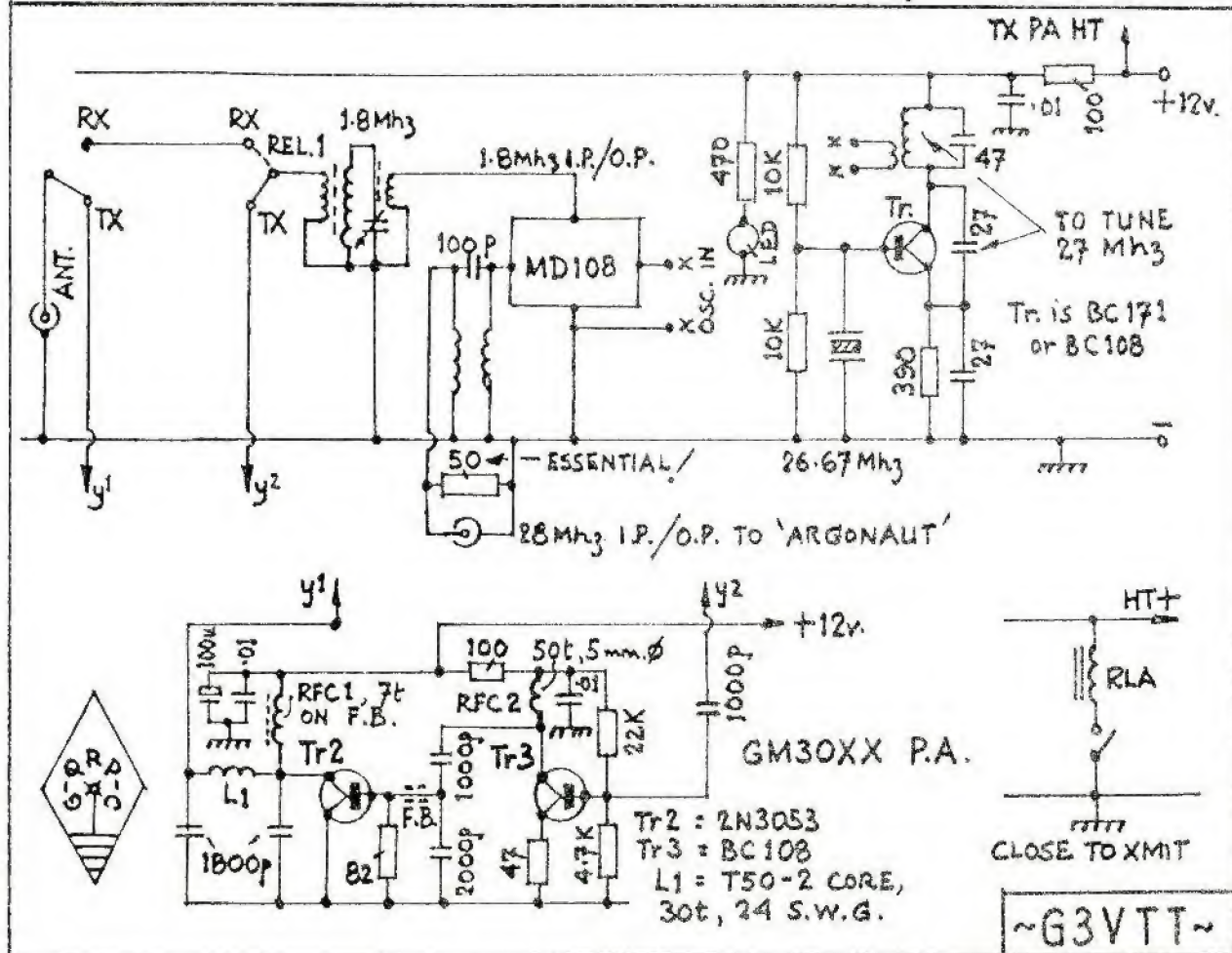
Reference: ARRL Solid State Design by W7ZOI/W1FB, pages 38/206.

## G3ROO Tip

That old unused diecast box full of holes? Cover the holes on the inside with PVC tape and fill the holes from the outside with "Plastic Padding". Allow to cure and then sand off. A quick coat of paint and it is ready for the next VFO!

(P.S. - Rf leakage through holes at HF is virtually zero as they are nowhere near half a wavelength in diameter!)

# 37 160m. TRANSVERTER — 'ARGONAUT' 28MHz > 1.8MHz — BY G3VTT



This simple transverter is suitable for CW only, with about 2.5 watts input and 1 watt RF out. The circuit is derived from the GM30XX PA design from "SPRAT" No.20, Autumn 1979, and the simple Top Band converter shown in Radio Communication, Technical Topics, February 1979. I have simply "bolted" the two together to make about the simplest possible CW transverter (only one mixer).

The project started when G3ZWH was being worked using an Argonaut on 28.5MHz and the receiving portion of the transverter, which was built first. When the key was accidentally pressed, RF was found to be generated at the input of the MD108, subsequently Doug was worked at about 8 miles range with an estimated 10mW output.

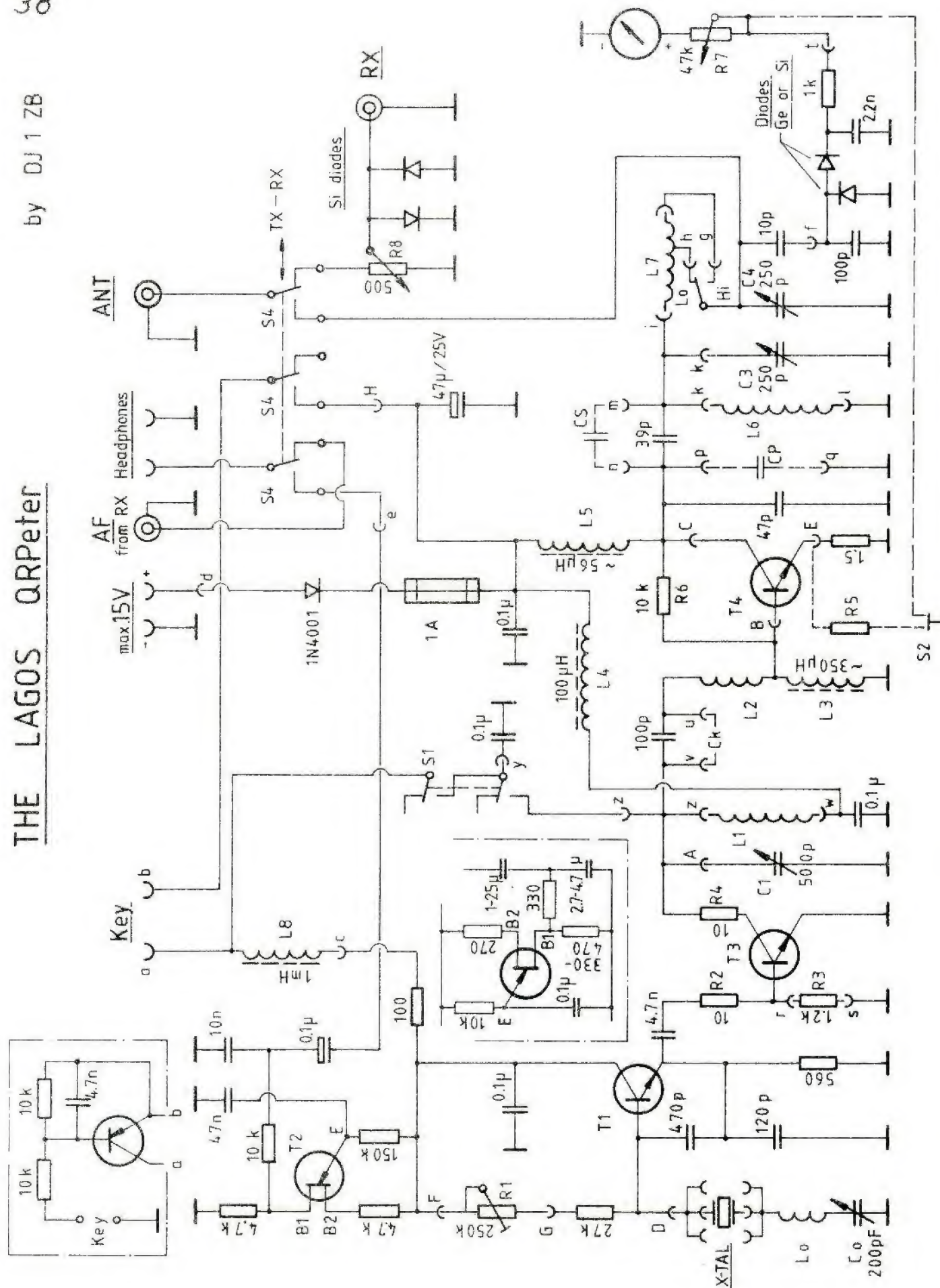
As usual "SPRAT" provided an ideal circuit for a project, in this case the GM30XX article. By adding a changeover relay, full transmit and receive is now possible, although only by using a toggle transmit/receive switch. (The Argonaut has a full QSK system and I did not want to break into the Ten-Tec changeover electronics — pun not intended!).

The input is about 2.5 watts with the Driver emitter resistor set to 47 ohms. Heat sinks are recommended on both Driver and PA. Be careful not to overload the input to the MD108 as it has only 400mW dissipation. (I have run the full two watts into the Mixer with no damage, but it's always best to stick to the maker's dissipation levels!). The 28.5MHz input is used to peak all coils for maximum output on 1830KHz. By using the 26.67MHz crystal and setting the Argonaut dial to 28.5MHz, output was obtained on 1.8MHz. L2 & L3 are 12 turns of 26 SWG wire on 5mm formers.

If anyone wishes to build the receiver section alone, it can be recommended even for DX working. During initial trials, a UL7 was heard on 1850KHz at good strength. The output pi-network is a single section of the GM30XX design, there was no room in the case for the other section. (use an AFU!). The final transverter fits into a tiny 9 x 10.5 cm box.



## THE LAGOS QRPeter



## The LAGOS QRPeter DJ1ZB

VXO - FD/FT - PA, 4 watts input on 14, 21 or 28MHz, 14 volt supply.

This simple transmitter was built for a business trip to Nigeria, in case a licence could be obtained there. Unfortunately reciprocal licences are not issued for visitors (only for residents), so the only chance to test the transmitter under a Nigerian callsign was from the shack of 5N7AKD, Ken, in Lagos (G3BQA, ex 9G1GD) one Sunday morning, resulting in a few contacts with Italy and Germany on 21MHz. Recently, however, the transmitter was used from the home QTH in the QRP overseas section of the RSGB 21MHz CW Contest, in which 60 QSOs and 1800 points were made.

The transmitter has mostly been used in combination with the Sony ICF-5900W dual conversion receiver, with reduced bandwidth in the second IF (smaller coupling capacitor C58 across ceramic filter). This receiver is very suitable for travelling (but look for minimum backlash in both dial drives) and covers the CW portions of the 7 to 28MHz amateur bands. For this reason the transmitter may also be operated on 7MHz as a straight amplifier.

### The Circuit

Despite modern advances, crystal controlled transmitters remain the simplest of all. As some frequency pulling is desirable, the crystals are excited in their fundamental mode and doubling or tripling is used. With toroidal coils, all three stages can be arranged on a single PCB without the need for screening.

An untuned Colpitts oscillator is used, with sockets for FT243, HC-6/U and HC-25/U crystals. The capacitive divider is optimised for frequencies between 4.6 and 11MHz, so all the bands can be reached by either doubling or tripling. Almost any silicon NPN transistor will work as T1. The oscillator output voltage can be controlled by varying the bias resistor R1 (250K or 500K).

The VXO supply voltage is keyed and for CW monitoring a simple unijunction transistor T2, 2N2646 tone oscillator is operated on the same supply. A special keying transistor (T6, BC108) is recommended if keying to ground is desired.

T3 is operated in Class C as a doubler or tripler. It is adjusted for best tripling to 28MHz by varying resistor R3 (use a 5K pre-set first and replace the optimum value by the next highest fixed resistor). R2 & R4 will prevent parametric and VHF oscillations. To generate the PA driving power required, a good UHF transistor such as the 2N3866 or 2N5109 should be used in this stage, cooled by a Wakefield NF-207 or similar heatsink. The tuning capacitor, C1, in the collector tuned circuit, is of fairly high value to achieve a high loaded Q, to suppress unwanted harmonics and allow tuning to 7MHz. A spectrum analyser test showed that all unwanted crystal harmonics are suppressed by 40dB or more at the transmitter output.

To net the VXO on to a calling station, the collector tuned circuit is loaded by section I of switch S1 and a low impedance capacitor (0.1mfd disc ceramic). This is the simplest way to disable the PA without affecting the oscillator frequency (keying T3 in the collector current path would result in increased base current, causing a noticeable frequency error). Lead lengths from switch S1/I to the 0.1mfd capacitor and the "hot" end of the tuned circuit must be kept as short as possible, however.

The coupling capacitor C2 matches the doubler/tripler load resistance to the low PA input impedance. It is optimised for 28MHz, but can be retained on the lower bands as well, because the lower driving power required on these bands results in a somewhat higher input impedance. Soldering posts are provided on the PCB, however, to add another capacitor for 7MHz operation.

The PA transistor T4 is a 2N3553 mounted in a Jermyn 1101A heatsink with some silicon grease inside to improve the heat conduction from the TO-39 can.



The heatsink is fixed to the front side of the metal box which houses the transmitter, and the PCB placed close enough to allow the normal TO-39 lead length of T4 to reach the PCB. With the same mounting arrangement, the 2N3553 & Jermyn heatsink may be replaced by the 2N3375 (same chip but TO-60 stud mounted version) enabling the PA input to be increased to the G-QRP-C limit of 5 watts. Under these conditions, the PA will not be damaged even by severe mismatches and a supply of over 15 volts, because the VCEO max of the transistor is 40 volts and the full DC power input can be dissipated by the heatsink.

The PA output circuit was previously described in the G-QRP-C data sheet "Transistor PA Design - the Safe Way". Coil L2 prevents VHF oscillation in the PA. The different inductance values of base and collector chokes L3 & L5 are necessary to avoid TGTP oscillation at MF. The 10K feedback resistor (R6) from collector to base also helps to prevent parasitic oscillation under certain tuning conditions.

The PA tank circuit will match coaxial loads as well as random wire or Windom aeriels. For low loss matching, switch S3 changes the series inductance for either low or high impedance loads. If the transmitter is to be used for coaxial loads only, S3 and the coil extension may be omitted. Capacitors C3 & C4 are tuned for maximum aerial voltage, with the optimum setting of S3. R7 sets the meter sensitivity to suit different load conditions.

The position of the doubler/tripler tuning capacitor (C1) depends upon frequency only and can be marked. For those who may find it more convenient, the push-button switch S2 can be installed. When the PA is de-tuned, with no reading at the aerial output, C1 can be tuned for maximum PA emitter current by pressing S2. The value of R5 depends on the meter FSD (0.5 volt DC max at the PA emitter). After an aerial output reading has been taken, C3, C4 and C1 should be re-tuned for best output.

Whilst 15 volts is the recommended maximum supply voltage, the transmitter will operate down to less than 10 volts with reduced output power. Bias resistor R1 may be decreased under these conditions. At 10 volts the input will be 2 watts. The transmitter may therefore be operated from dry batteries (10 cells) down to less than one volt per cell.

S4 is the transmit/receive switch, a three pole Marquardt miniature unit. Section I changes the aerial from TX to RX. Section II disconnects the VXO supply on receive. Section III connects the headphones to the RX on receive and to the tone oscillator in the transmit position.

S1 changes the circuit from normal operation to SPOT. Section I loads the doubler/tripler output as mentioned earlier. It also feeds supply voltage to the VXO via section II. The contact arrangement ensures that the VXO is not excited before the doubler/tripler output has been loaded. During SPOT, S4 must remain in the receive position (otherwise the headphones are disconnected from the receiver).

R8 is a simple attenuator in the receiver aerial path, to avoid input overload when good aeriels are used. The two anti-parallel diodes will protect the receiver input against residual RF voltages from the transmitter.

The series diode in the supply line will protect the transistors in case of wrong polarity. The fuse may seem pointless in a transistor circuit but if transistors T3 or T4 should break down (which should only happen if experimenting or with an abnormally high supply voltage) the fuse will blow and the RF chokes L3 to L5 & associated resistors will not burn up.

#### Mechanical Layout

Minimum size was a design goal, so it was decided to omit a band switch and to solder-in the coils (L1, L6 & L7) and additional capacitors (Cp, Cs & Ck) for a

specific band. For the same reason solid dielectric variable capacitors were used. So it was possible to build the whole transmitter into a Teko 4/B aluminium box (137 x 70 x 40 mm). Critical RF lead lengths (from the PCB to the crystal sockets, the variable capacitors and to S1 and S3) are kept as short as possible. The PCB is grounded to the aluminium box by four metal screws.

If there are no space limitations, a band switch and air-spaced variable capacitors can be used, of course. A variable capacitor of good mechanical design is especially desirable in the VXO if a large amount of frequency pulling is needed.

#### VXO and Crystals

The author has used either 4.6MHz or 7MHz crystals for 14MHz; 7MHz or 10.5MHz crystals for 21MHz and 9.3MHz crystals (or 28MHz 3rd overtone crystals in fundamental mode) for 28MHz.

Frequency pulling without a series coil  $L_o$  was almost zero with FT-243 crystals (4.6 and 7MHz) and fair (about 10KHz) with HC-6/U and HC-25/U crystals on 21 and 28MHz. For the RSGB 21MHz CW Contest, a  $9\mu\text{H}$  coil was inserted for  $L_o$ , giving almost 30KHz pulling range with 10.5MHz HC-6/U and 4 to 5KHz with 7MHz FT-243 crystals on the final frequency. A maximum  $L_o$  of  $15\mu\text{H}$  seemed possible for the 10.5MHz HC-6/U crystals, giving a pulling range of 44KHz on 21MHz, but resistor R1 had to be reduced to retain sufficient drive to the doubler stage. Later on a maximum  $L_o$  of  $25\mu\text{H}$  was found possible for 7MHz FT-243 crystals, resulting in a pulling range of 7 to 8KHz at the fundamental frequency and correspondingly more on the higher bands.

The above shows that experiments on the VXO are highly recommended and may give astonishing results. However, with  $C_o$  near minimum capacity, bias resistor R1 may need some adjustment for good keying characteristics, as some crystals may not start to oscillate the instant that the key is closed and readability could be affected.

It is hoped that this transmitter will increase QRP activity on the higher bands. the author has several 10.5MHz crystals to offer. Also, HC-25/U crystals 28045KHz, 28070, 28090 and 28100 crystals are available in Germany.

#### Coil Winding Data (all Amidon T-50-6) and Additional Capacitors for the Various Bands

MHz	<u>L1</u>	<u>L6</u>	<u>L7</u>	<u>Cp</u>	<u>Cs</u>	<u>Ck</u>
28	4 turns	9 turns	LO - 15 turns HI - 21 turns	-	-	-
21	4 turns	12 turns	LO - 17 turns HI - 25 turns	27 pF	22 pF	-
14	9 turns	12 turns	LO - 21 turns HI - 30 turns	47 pF	39 pF	-
7	14 turns and 120 ohms in parallel	23 turns	LO - 30 turns HI - 42 turns	330 pF	120 pF	220 pF

L2: 8/9 turns, 0.5mm copper lacquered, self-supporting, formed on 3mm dia mandrel.

L3: Siemens RFI Suppressor Choke type B82111-A-C29,  $350\mu\text{H}/0.1\text{A}$

L5: Siemens RFI Suppressor Choke type B82111-A-C26,  $55\mu\text{H}/0.5\text{A}$ .

L4 & L8 are moulded RFCs



## FET Regenerative Receiver Ha-Jo Brandt DJ1ZB

This simple receiver is an improved version of an O-T-2 the author designed back in 1961. In combination with a three watt transmitter (three watts all band VFO TTX), it has been used in all NFDs since 1969 and in the DL QRP Contests with good results. Combined with a 144/28MHz convertor (two 40673 amplifiers and a 40673 mixer) it is also used to cover the whole of the 144MHz band for all modes.

In the regeneration detector, a 2N4416 FET is used as the equivalent of a plate tube detector. The operating point is determined by the source resistor  $R_s$  and the drain resistance  $R_d$ . Due to FET data variations, these resistors must be optimised by experiment for best detection and regeneration performance. FETs with low  $I_{DSS}$  are to be preferred.  $R_s$  is usually optimum around 2K2, whilst  $R_d$  may be as low as 820 ohms for high  $I_{DSS}$  devices.

Tuning is accomplished by a 25pF air-spaced capacitor, bandspread by capacitor  $C_p$  and  $C_s$  on the higher bands to spread the amateur bands to about 120 degrees of a semi-circle drive dial. The coil has a tap to be grounded, the upper part of  $L_r$  being used for regeneration and the lower part for tuning. Regeneration control band-capacitance effects may affect the tuning (regeneration control by a DC potentiometer has been avoided because the operating point of the detector would be shifted too). On the higher bands, series capacitor  $C_r$  has had to be added because the few turns of  $L_r$  make fine adjustment impossible.

The aerial energy is fed into the circuit via a T attenuator of about 8dB,  $Z = 60$  ohms (not critical), which helps to isolate the regenerative circuit from resonant aerial absorption effects. 1N914 diodes protect the circuit against transmitter signals.  $C_a$  is a transforming coupling capacitor, determined experimentally for each band ( $C_a$  too low: low sensitivity.  $C_a$  too high: too much loading of the resonant circuit without improved selectivity).

The detector supply voltage is stabilised by a planar zener diode to 5.6 volts. Therefore, decreasing battery voltage down to about 6 volts does not affect the detector operation. A three stage R/C filter has to be inserted before the AF volume control and roughly designed for phone (3.9nF) and CW (15-22nF), bandwidth. The two stage AF amplifier is conventional. The RF choke in the headphone lead prevents RF picked up by this lead from reaching  $Ts3$ . Otherwise AF oscillation may develop when regeneration is active, including all stages of the receiver.

For use with the TTX mentioned earlier, a receiver blocking circuit and an input lead for monitoring CW signals from the TTX tone oscillator have been added. During transmit, 6 to 18 volts are added to point B, and transistor  $Ts4$  clamps the detector output.

To spot the accompanied TX to the calling frequency of another station, it's power must be decreased to a very low level otherwise the receiver will block. This problem has been solved by a potentiometer control in the pre-driver of the TTX.

Tuned Circuit Data - Coil former - 10mm dia, with VHF tuning core. Wire - 0.35mm lacquered copper. (NOTE: Nearest SWG to 0.35mm is 29SWG, suggest 28 or 30SWG, unless you can find 29SWG. For USA readers, use same gauge or drop a gauge...G3RJV)

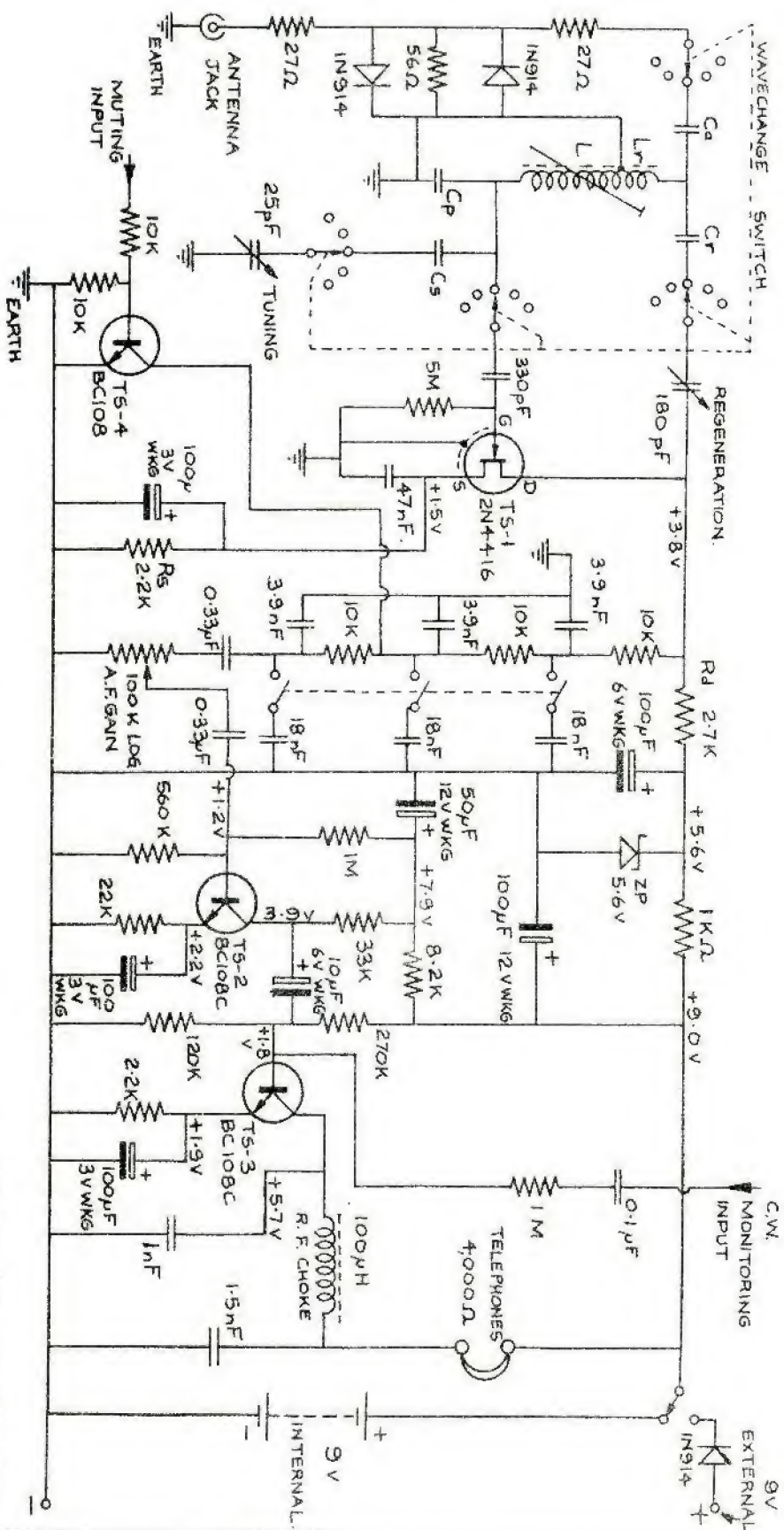
Band	$L$ - turns - $L_r$		$C_p$	$C_s$	$C_a$	$C_r$
80	64	5	100	-	470	-
40	26	2	100	15	100	82
20	16	2	47	12	39	47
15	9	2	33	12	33	39
10	8	2	15	18	33	47

All capacitors in pF

# F.E.T. Regenerative Receiver type 0-T-2

DESIGNED BY  
DJ1ZB

NOTE : ALL D.C. VOLTAGES  
MEASURED WITH  
INSTRUMENT OF RESISTANCE  
20 K $\Omega$ /VOLT. (WITH  
RESPECT TO EARTH)



DWN	KAS
DATE	3.7.75



SM06259 (ex-SM7WK)

(Emil, SM06259, is now 71 years of age. He was SM7WK in 1929, and had achieved a 4 watt WAC by 1937. His list of DX heard on this receiver is very impressive, especially as his antenna is only 5 metres of wire nailed to the wall of a building in a very noisy location in Stockholm)

The general method of construction and the circuit should be clear from the diagrams, except that Emil has omitted the antenna tapping switch from the layout diagrams. This switch was a late addition to improve performance on 21MHz. There is room for it above the bandspread capacitor. When assembling the receiver, note in particular that the receiver board (10 way tagstrip) must not be rigidly mounted on the panel, as this may cause microphony. Instead the board should be floated by means of sponge rubber or similar mounting pads. Emil stresses the need to use high quality capacitors for bandsetting and bandspread. Jackson Bros. capacitors coupled to Jackson epicyclic drives are recommended.

The coil is wound on an empty plastic pill container with match sticks glued around it as shown. It covers 5 to 21+MHz, so if this type is used, a transistor with high gain should be selected for the first stage. The other two transistors are not critical.

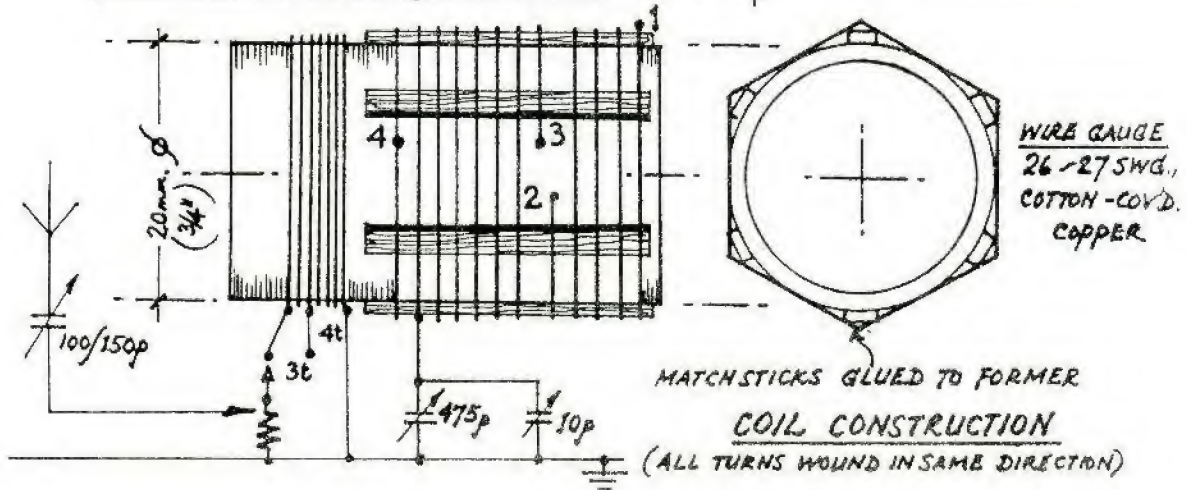
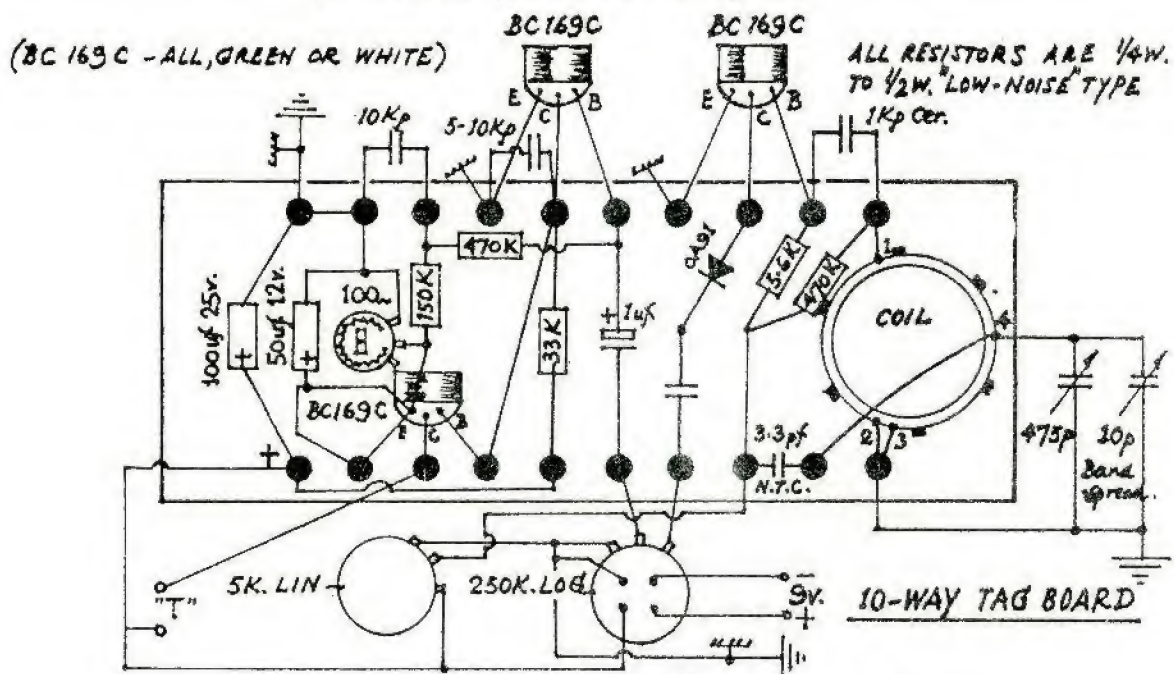
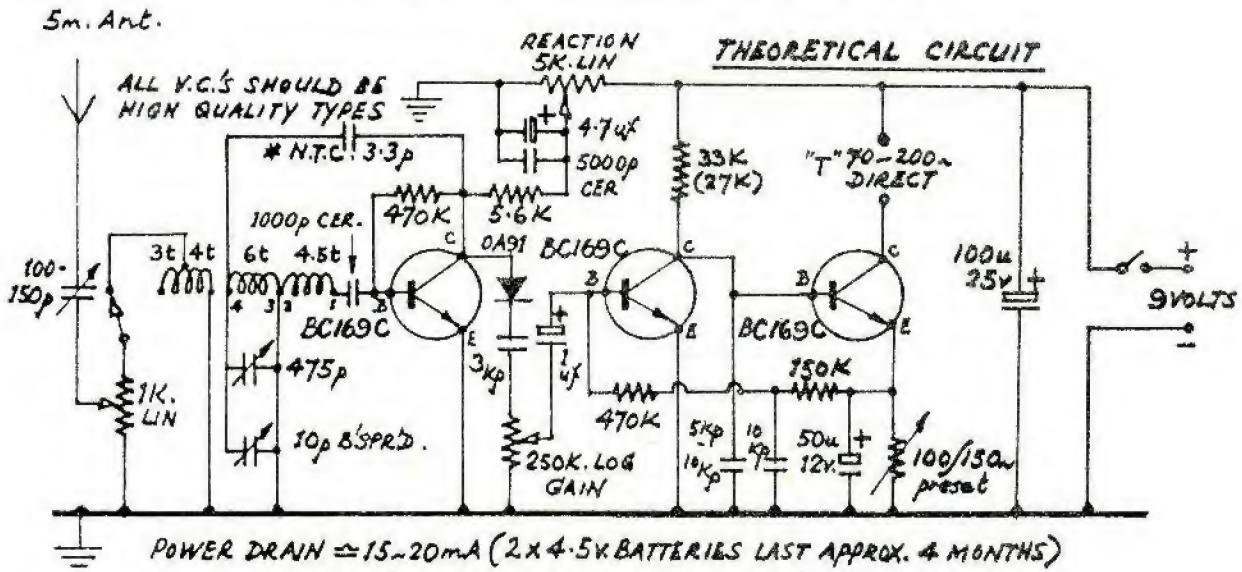
The differences between the original design and the modified front end shown in a separate diagram are as follows:- The 4.7pF fixed feedback capacitor is replaced by a 1 - 7.5pF ceramic trimmer, thus allowing the amount of feedback to be adjusted easily. This adjustment should be made with the 5K reaction control in its centre position, the antenna connected and the antenna series capacitor at its normal setting. The 1mfd audio coupling capacitor has been replaced by a 3KP Mylar capacitor, thus decreasing the bandwidth and improving CW reception. In the modified version, the coil is mounted in a screening can. This can should have a diameter at least twice that of the coil former. Owing to his noisy location Emil has separated the antenna coil from the tuning/reaction coil, and put a Faraday shield between them. This consists of a grid of brass wires with one end soldered to the chassis. It eliminates all capacitive coupling between the coils and Emil claims that in his difficult location it reduces electrical interference. In most locations it should be unnecessary.

Emil does not state how he sets up the 100 ohm resistor in the output transistor emitter circuit, but it is suggested that it be set at maximum initially, then adjusted for best audio output.

In constructing this receiver, build the first stage as if it were going to be used as a high stability VFO - the more rigid the mechanical construction the better will be the results. If the receiver goes out of oscillation at certain frequencies, even with the reaction control fully advanced, the trouble can usually be cleared by reducing the capacitance of the variable capacitor in series with the antenna.

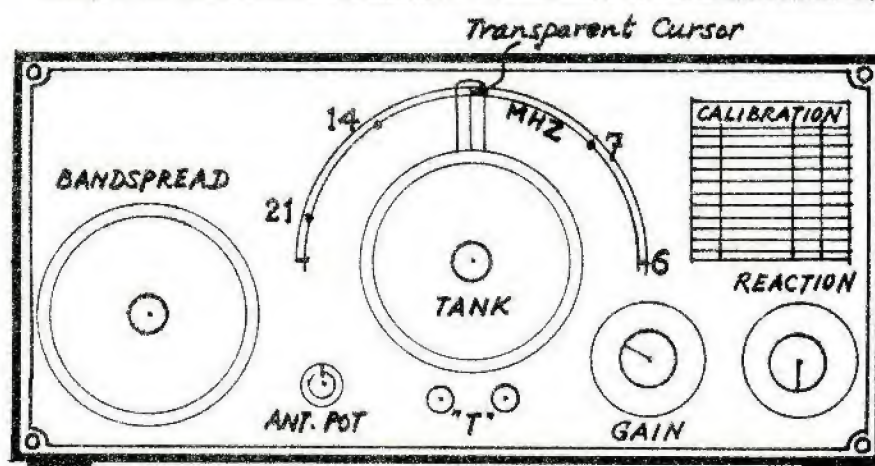
"SILVER TERN"-3 TRANS.-SUPER REFLEX  
15 TO 60 METRES "ALL-WEATHER" RX.  
SMØ6259 (EX. SM7WK) ~ G. ØRP.C. 354

45





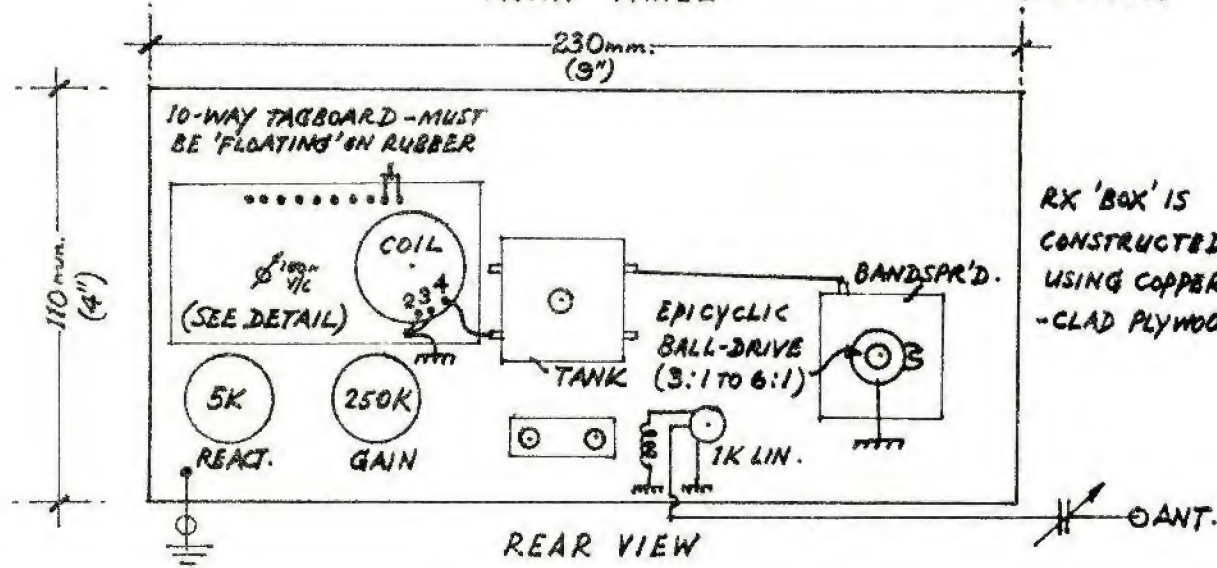
"SILVER TERN" SUPER 3 TRANSISTOR RX  
SMØ6259 G-QRP-C NO. 354



PANEL MADE OF  
COPPER SHEET,  
COVERED WITH  
BLACK 'FABLOX'  
OR SIMILAR

FRONT PANEL

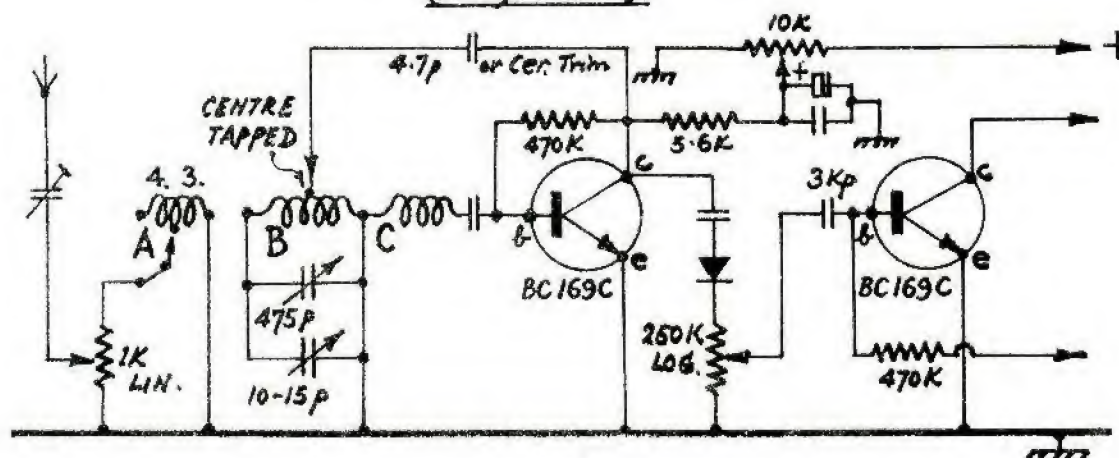
Rubber Feet

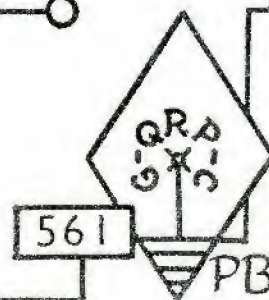
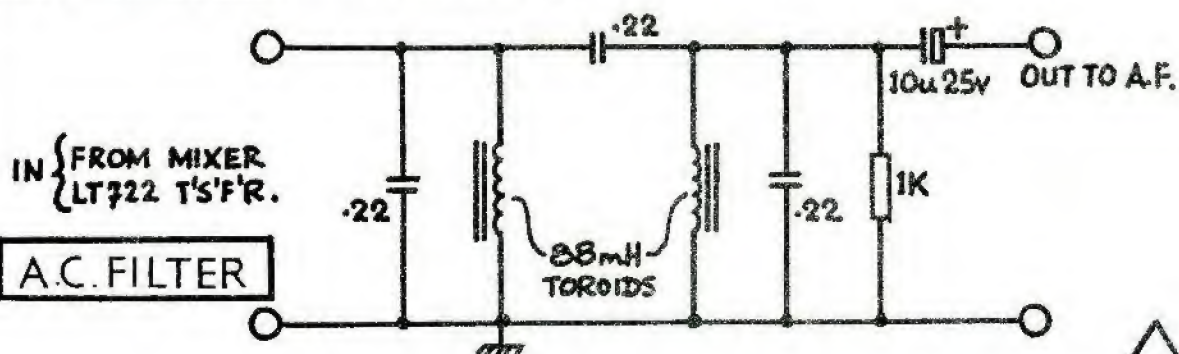
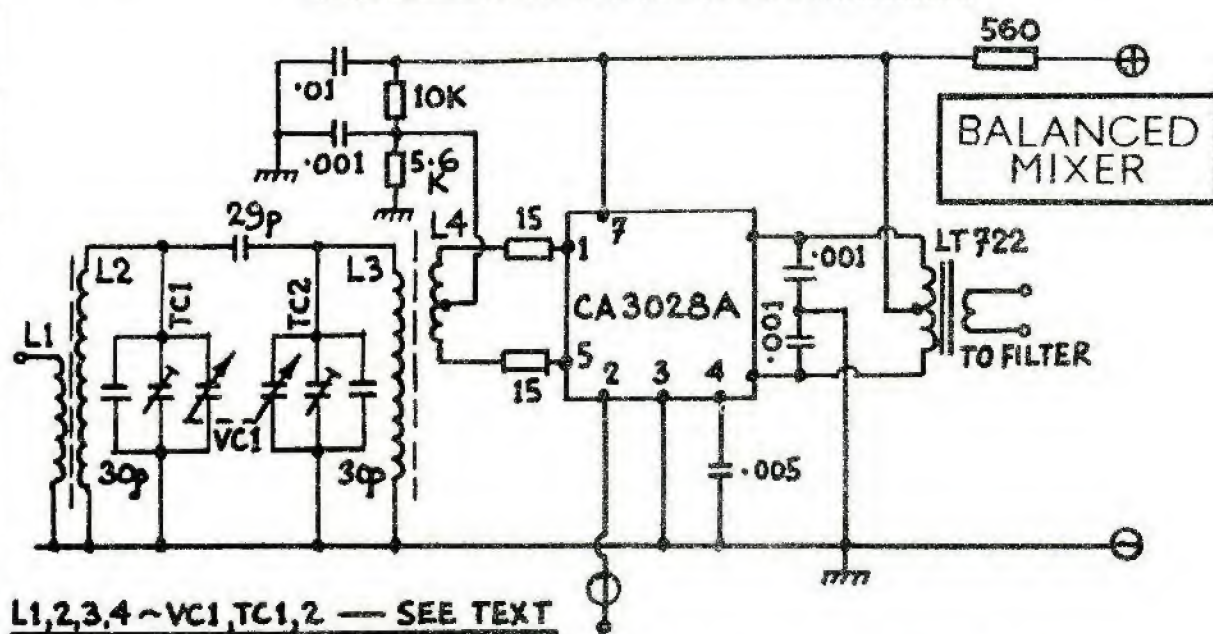
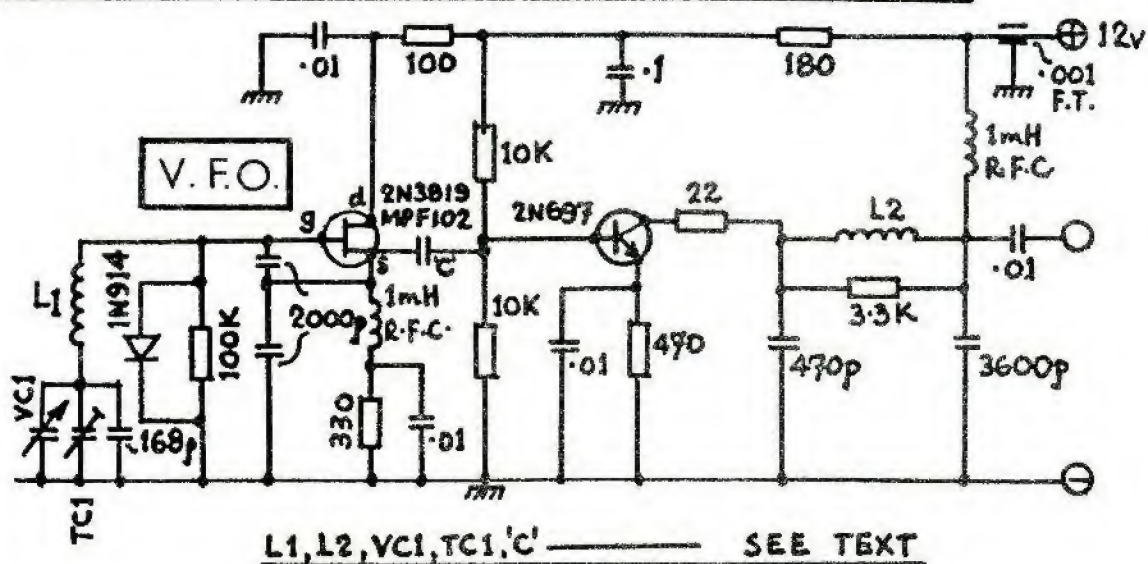


RX 'BOX' IS  
CONSTRUCTED  
USING COPPER-  
CLAD PLYWOOD

REAR VIEW

MODS. - "SILVER TERN 3"  
(SMØ6259)







## Direct Conversion Receiver for Eighty

By Peter Brent.

This receiver was constructed for conversion to a transceiver at a later date. The VFO, to an ARRL design, covers 1.75 to 2.0MHz, giving a 160m option. The second harmonic is used for 80m injection to a CA3028A mixer. The AF circuits are to be modified for active filtering but the basic circuit does an adequate job using an RSGB design and a 1½" tweeter loudspeaker to restrict response. The VFO gives about a 5KHz band overlap. Any suitable coil could be used for L1 but the required Q of over 100 probably excludes the use of toroid coils. The receiver requires 12 volts at 60mA and gives good results with a short indoor aerial.

### The VFO

L1 - Cambion 2260-05  
 L2 - 2 layers 30SWG on ¼"dia, 1¼" long former (no core)  
 VC1 - Jackson U101 100pF  
 TC1 - Jackson 330 30pF tubular trimmer

### The BALANCED MIXER

L1 - 5 turns, 24SWG over L2  
 L2, L3 - 45 turns, 24SWG on Amidon T-50-2  
 L4 - 10 turns, CT, single strand PVC wire, over L3  
 TC1, TC2 - 30pF ceramic or silver mica trimmers

## The GM30XX Transverter

Having a transceiver which tunes 5.1 to 5.2MHz, transvertors were needed for the amateur bands and, as building a six-band switched unit would not have been easy, it was decided to take the easier but more expensive way and build six separate units. This had the advantage of being easier to optimise each one for best performance on its own band.

The circuit, which is fairly conventional, is a mixture of circuits from various sources. The receiver needs no comment, it is simply a 3N201 MOSFET mixer with a double tuned band pass filter.

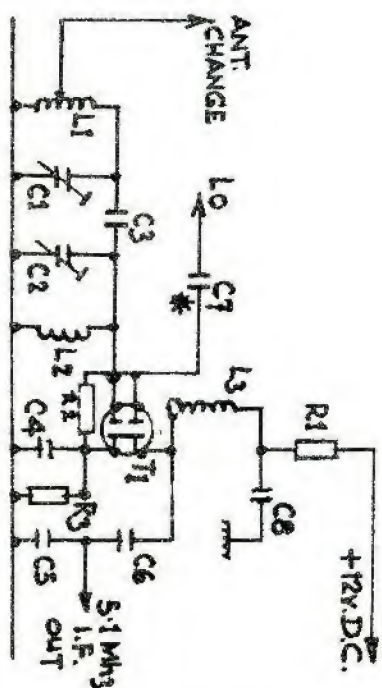
The transmitter is also conventional but will need some optimising for correct performance, (see components marked \* , C21, R15, R18, and R19). C21 will only be required on the HF bands. R15 is adjusted for the required drive level. Make R18 as large as possible and R19 as small as possible for best stability and drive.

### Some Values as a Guide

	L5	L6	L7		C16	C17	C19	C20	C22	C32
1.8	50 turns	36 SWG	)	All coils wound on	1.8	1000 - 2000pF				
3.5	40 turns	36 SWG	)	6 pin ½"sq. can,	3.5	330 - 1000pF				Big
7	20 turns	36 SWG	)	¾"high, coil size	7	270 - 1000pF				value
14	15 turns	32 SWG	)	3/16" with core.	14	100 - 1000pF				at
21	14 turns	32 SWG	)		21	47 - 470pF				bottom
28	14 turns	32 SWG	)		28	33 - 470pF				

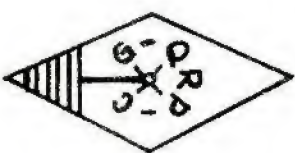
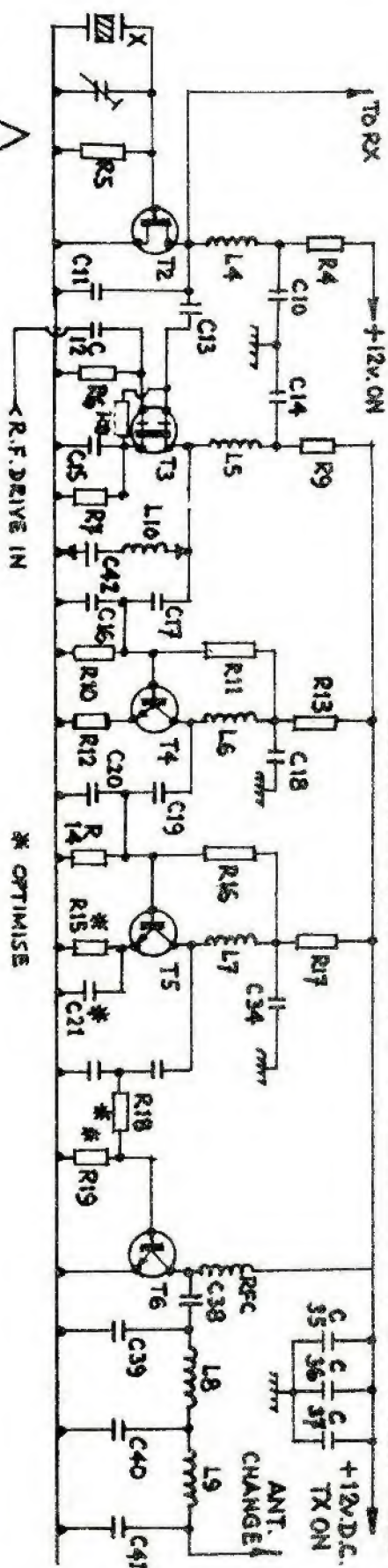
L10 - C42 reqd if crystal too close to drive freq., as it is a single-ended mixer.

C1 C2 C3 - to suit band	C7 C12 - 15pF (adjust	C38 - 0.01mfd
C4 - 0.1mfd LF/ 0.01mfd HF	for opt)	C35 - 0.001mfd
C5 - 470pF	C10 C14 C18 ) 0.1mfd LF	C37 - 47mfd
C6 - 47pF	C34 C36 C21*) 0.01mfd HF	C39 C40 C41 to suit band.



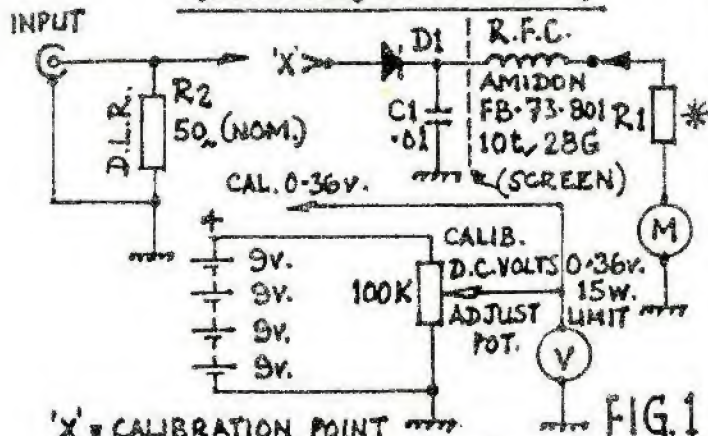
# • THE GM30XX TRANSVERTER •

R1 - 100	R11 - 1K	T1 - 3N201	L1 - TO SUIT BAND
R2 - 100K	R12 - 470	T2 - 3N201	L2 - " " "
R3 - 330	R13 - 100	T3 - 2N4416	L3 - 45L-36 S.W.G
R4 - 100	R14 - 220	T4 - BC109	L4 - TO SUIT XTAL
R5 - 100K	R15 - 470*	T5 - BC109	L5 - TO SUIT BAND
R6 - 100K	R16 - 1K	T6 - 2N3375	L6 - " " "
R7 - 300	R17 - 100		L7 - " " "
R8 - 100K	R18 - 3<100		L8 - " " "
R9 - 100	R19 - 5<50		L9 - " " "
R10 - 220			L10 -





## R.F. POWER WATTMETER



'X' = CALIBRATION POINT  
 V = EXTERNAL VTVM/FETVM/DVM TO  
 READOUT CALIBRATION VOLTAGE  
 M = MICRO./MILLIAMMETER.  
 \* R1 - SEE TEXT

FIG. 1

## R.F. POWER W/METER - CAL. FORMULAE

$$AV. P_{\text{O}} \text{ WATTS} = \frac{(E_{\text{peak D.C.}})^2}{2R_{\text{ (D.L.R.)}}}$$

OR

$$E_{\text{DC CAL. VOLTS}} = \sqrt{AV. P_{\text{O}} W. \times 2R_{\text{ (D.L.R.)}}}$$

## AUTHOR'S CALIBRATION TABLE

(ACTUAL 'R' = 51.9Ω)

P <sub>O</sub>	D.C. CAL. VOLTS	P <sub>O</sub>	D.C. CAL. VOLTS
10	32.22 V.D.C.	.9	9.67 V.D.C.
9	30.56 "	.8	9.11 "
8	28.82 "	.7	8.52 "
7	26.96 "	.6	7.89 "
6	24.96 "	.5	7.20 "
5	22.78 "	.4	6.56 "
1	10.19 "		

FIG. 2

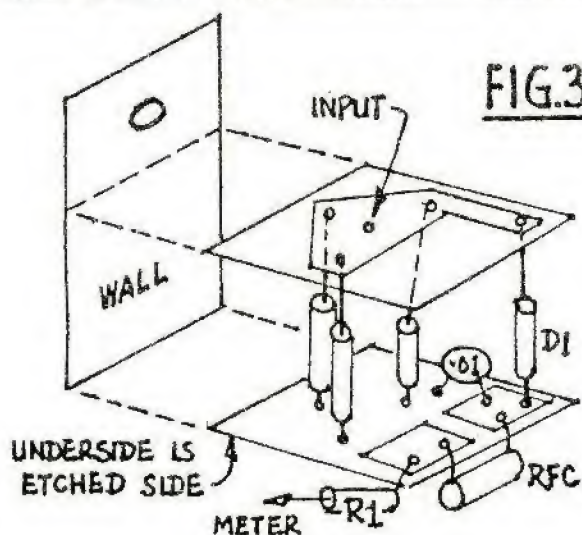
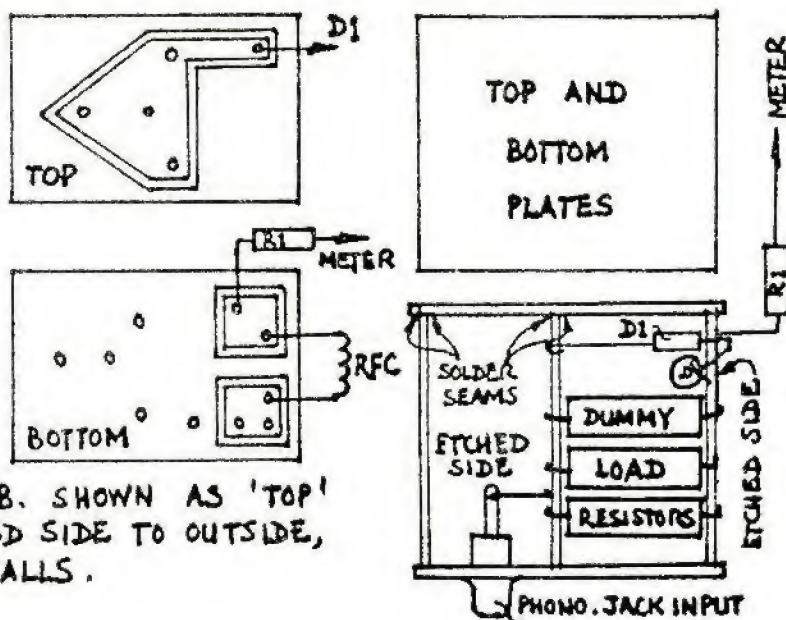


FIG. 3



ETCHED SIDE OF DOUBLE-CLAD P.C.B. SHOWN AS 'TOP' AND 'BOTTOM' OF CUBE. I.E., ETCHED SIDE TO OUTSIDE, AND RESISTORS MOUNTED INSIDE WALLS.

## RF Power Wattmeter

Fig 1 shows the circuit of a simple, easily calibrated and accurate RF output power wattmeter that can be used in conjunction with an external VTM/FETVM/DVM, or an internal microammeter/milliammeter. Operation is quite simple; it is an AC peak voltage sensing circuit. When an AC or RF signal appears across the load R2, a voltage representing the AC peak level is rectified by D1 and charges C1 to that peak level. That voltage is then measured and the formula of Fig 2 used to calculate the average power output of the signal source.



Measurement of the peak voltage at C1 can be accomplished by using an external VTVM/FETVM/DVM with an input impedance of several megohms or more, or a self-contained micro or milliammeter. A voltmeter alone cannot be used due to its low input impedance, which will disturb the circuit impedance relationships. Likewise, "cheapie" VOMs are unlikely to provide accurate, dependable readings.

The circuitry for a self-contained meter consists of the RFC, R1 series dropping resistor and the meter. The RFC isolates the meter from RF, while R1 is chosen to produce full scale deflection on the meter at the desired upper power limit. If an external VTVM/FETVM/DVM is used, measurements should be taken from the (R1) end of the RFC and, as RF isolation is essential, the dummy load should be shielded.

### Construction

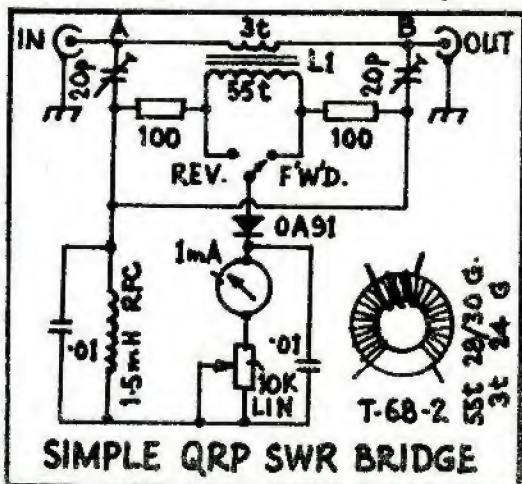
The major objective is the assembly of a dummy load from composition resistors and its mounting in a shielded enclosure. Fig 3 shows the use of double-clad PC stock as the walls of an enclosure for a unit able to dissipate 6 watts continuously. Two of the walls are etched for mounting the circuitry. Three 150 ohm, 2w carbon resistors are "sandwiched" between the etched walls and soldered in place and the remaining parts mounted and soldered to their appropriate foils. The remaining walls are soldered in place after accurately measuring the actual dummy load resistance; then calibration is complete. Any appropriate enclosure, such as a mini-box, may be used.

(In choosing resistors, the aim is to obtain a final 48-54 ohm value when a number of resistors are paralleled to give the desired power dissipation. In the author's case, 3 x 150 ohm 2W resistors gave a final value of 51.9 ohms).

### Calibration

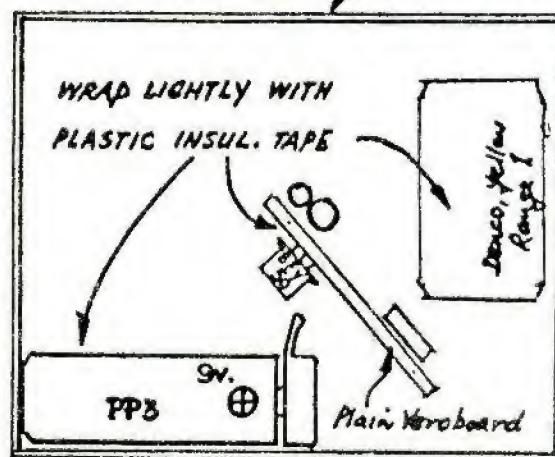
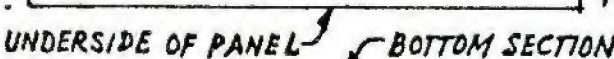
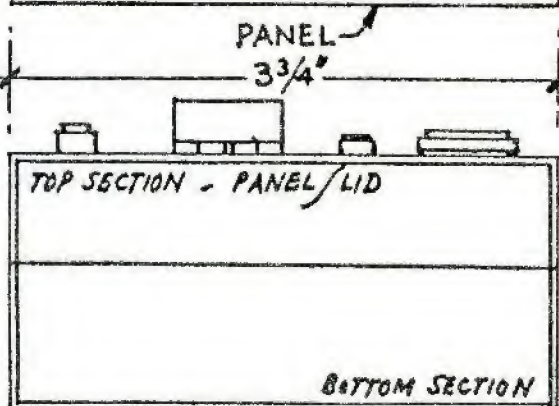
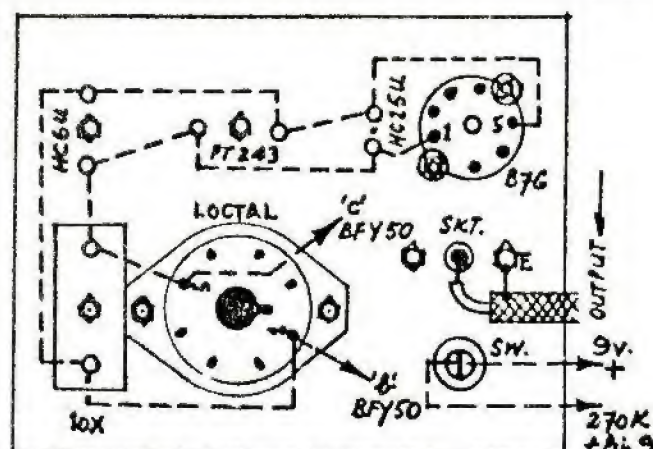
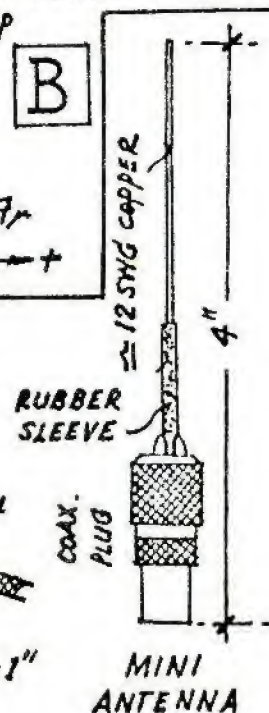
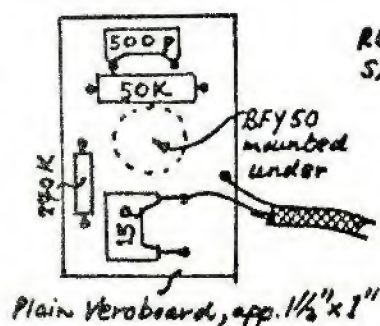
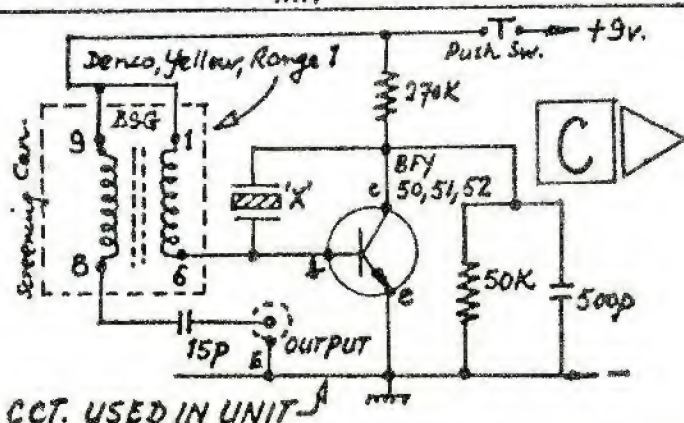
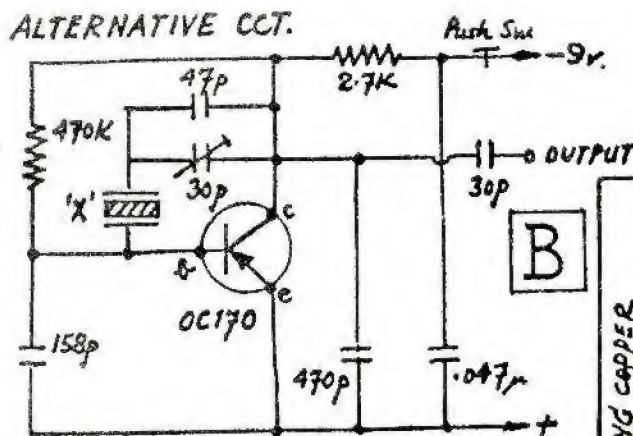
The advantage of this design is that it can be calibrated at DC. A variable DC supply of 0-36V (15w range), 0-33V (10w range) or 0-23V (5w range) is placed across ground and D1 (disconnected from R2!). A VTVM/FETVM/DVM is used to set the calibrating voltage to the calculated volts v watts level derived from the formula. The self-contained meter scale may be re-faced and marked in watts or the meter readings, in uA/ma vs watts referenced in a table. Readout accuracy can be checked by reversing the process, i.e. re-setting calibration voltage levels by readout in watts from the new meter face or table. If an external VTVM/FETVM/DVM is used, insert the peak voltage into the formula and calculate average power.

Once calibration is perfected, complete the enclosure after reconnecting D1 to the dummy load. Measurements are simple. Connect the TX to the input of the unit, apply power and read out watts average power. The unit may be used to calibrate an in-line wattmeter of the Breune type, which has been discussed in amateur literature (see CQ Magazine Jan 1974; May 1977 and August 1977).



This simple SWR Bridge is based upon the Short Wave Magazine circuit by G3RJV but without the DC amplifier. The completed bridge can be tested with a dummy load by adjusting the capacitors A and B for least REV (reverse) reading using a 50 ohm signal from a small transmitter. The bridge is then reversed and the process repeated several times.





A.W.MCNEILL ~ G3FCK  
~ G-QRP-C, NO.20 ~



There must be many who, like the writer, have acquired a collection of surplus crystals from suppliers but mostly from "junk" sales. This small unit was built to cope with the wide variety of bases encountered, using the circuit of Fig "C". It is not critical and can be wired on plain Veroboard, with flying leads to the crystal holders, switch and coax socket. Any type of box can hold the unit, the writer's being a small fibre jewel box with a snap-on lid.

A "mini antenna" was constructed as shown and this should suffice for most purposes, such as receiver calibration checks. When output to other equipment is required, the antenna is removed and coax cable used to couple them together. Two alternative circuits are shown for those with suitable junk boxes.

Zeroing of crystals, to coincide with frequency standards, is achieved by means of trimmer capacitors in circuits A and B and with the coil core in circuit C.

Other bases, such as 10XJ, HC31U, HC17U, etc. can be added as desired. Wire ended crystals are best tested by using the HC25U socket. If a 10X holder is not available, two wander-plug sockets can be used, appropriately spaced.

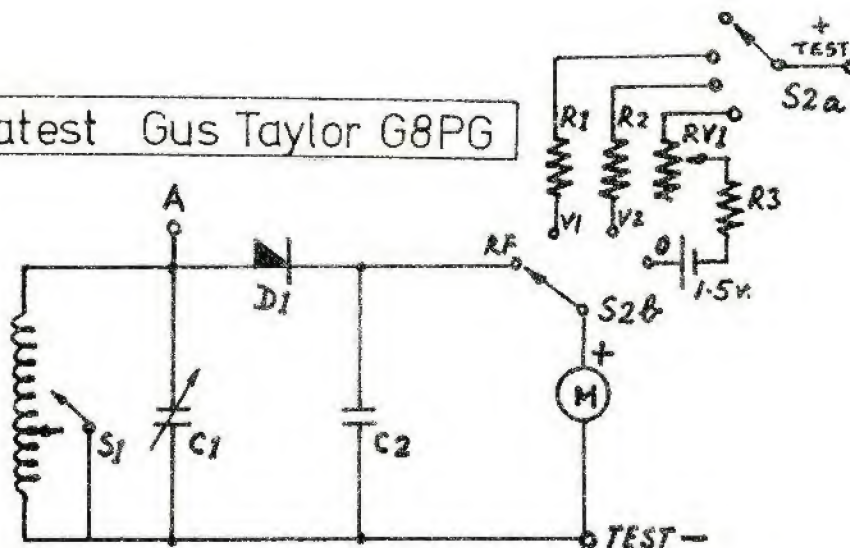
NB: The use of a push-type switch ensures longer battery life!

Parts Required: Crystal Holders (various), SP push switch biased off, TV coax socket, Coax cable, plastic box (approx 3½" x 3" x 1½").

Components: (for circuit C) BFY50 (or 51, 52), Veroboard - plain 1½" x 1", Denco coil (transistor, Range 1), B9A coil holder, 500pF ceramic capacitor, 15pF SM capacitor, 50K, 270K ¼watt resistors, PP3 battery, coax plug, 12 SWG wire & sleeving

## The Portatest Gus Taylor G8PG

- D1 - Germanium Diode
- M - 0-1mA meter
- C1 - 200pF
- C2 - 1000pF
- R1 - 15K 1%
- R2 - 300K 1%
- R3 - 1K
- VR1 - 1K
- L1 - Approx 30 turns  
1" diam, tap at  
7 turns.



This instrument gives the QRP operator an absorption wavemeter/radiation meter/volt meter/continuity tester, for /P and /M work. With S2 in the RF position it is an absorption wavemeter and radiation meter. Positions V1 & V2 provide 0 - 15v and 0 - 300v measurement. The 0 position provides continuity tests. It can be built in any box but if the coil is inside, a short length of wire can be attached to A for RF pick-up near an aerial. If 1% tolerance resistors are used, voltage readings will be accurate. If Coil L1 is adjusted to just cover 3.5MHz with C1 at maximum, it should be possible to cover all bands 3.5MHz to 21MHz in the RF position by adjusting the tap so that with S1 closed, the 14 & 21MHz bands are covered. If the 0 position is calibrated against known resistance values and a calibration chart made, resistance measurements may also be made. In this position VR1 is used for zero (FSD) setting. Apart from use with the rig, this unit can save the mobile operator a few pounds if he has electrical faults on the road.



The design is by no means original but might be of interest to other readers. Fig 1 shows the circuit diagram and Fig 2 the printed circuit board and component layout. The calibrator uses TTL logic circuitry which means that it needs about 100mA at 4.5v but, since it is only intermittently used, this is not considered a handicap. CMOS technology would have decreased the power consumption but the harmonic content of the output signal would not have been nearly so high, due to the lower switching speed of CMOS devices.

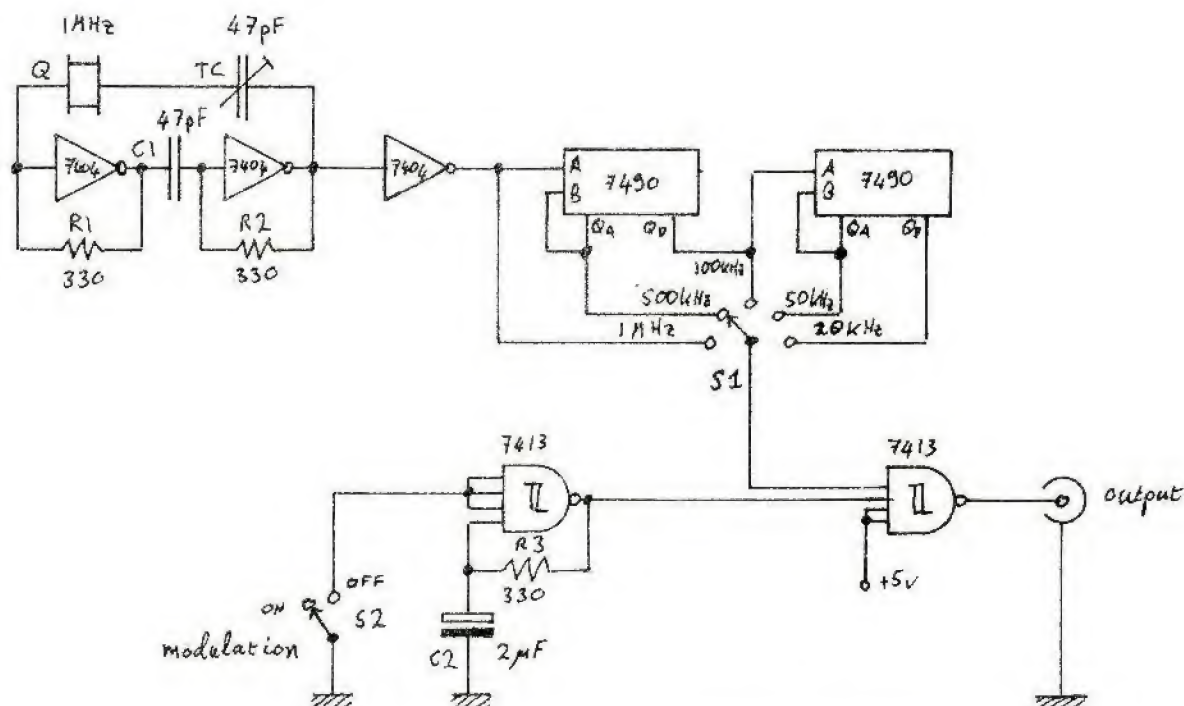
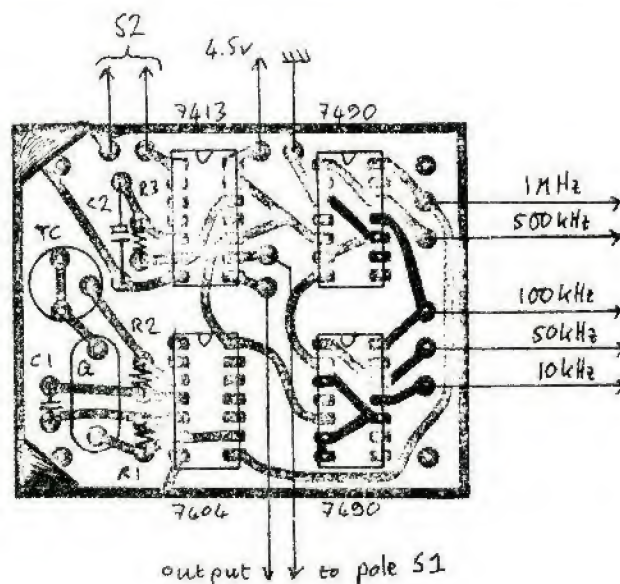
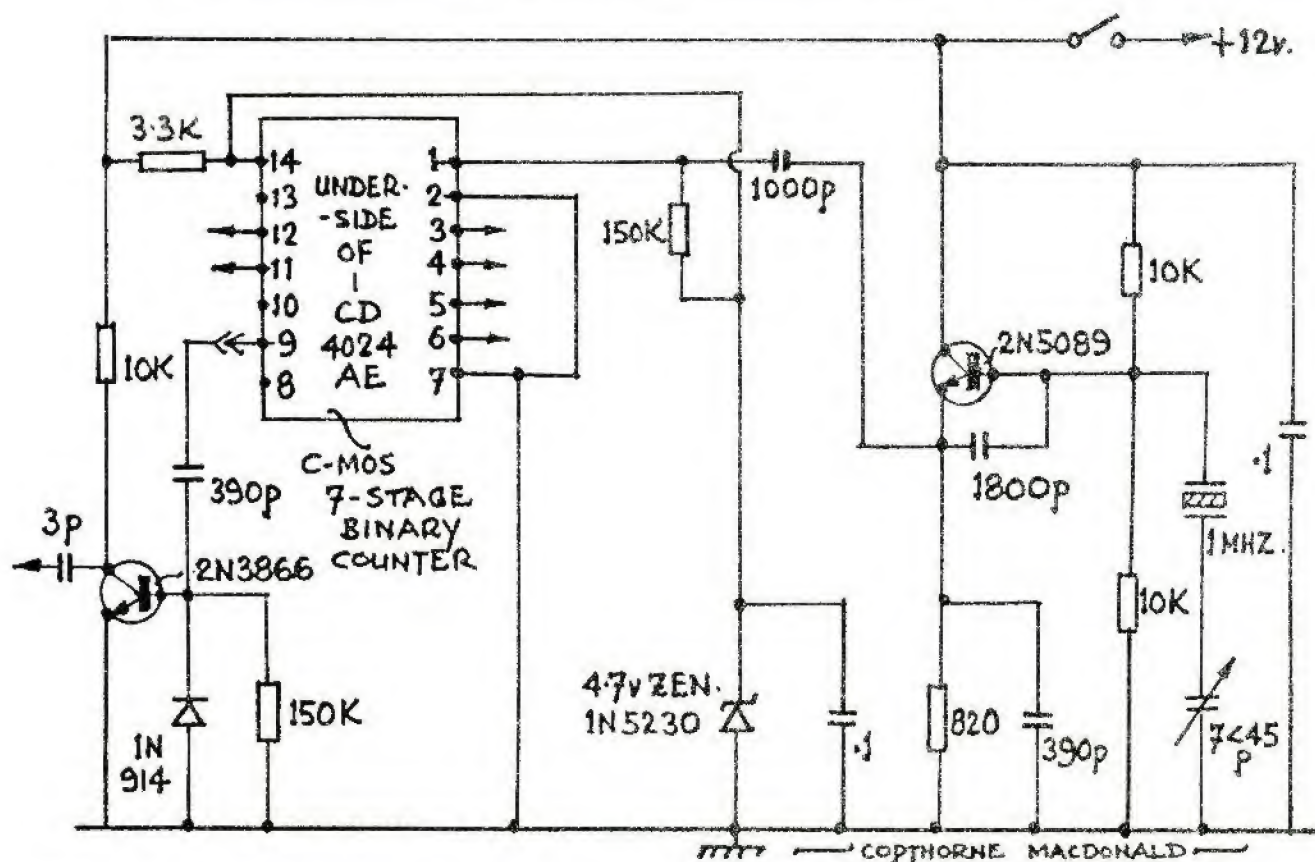


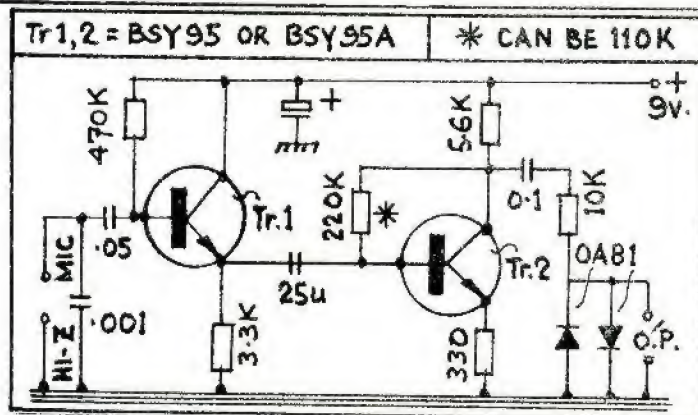
Figure 1 : Circuit diagram of crystal calibrator



ODD-FREQUENCY XTAL. CALIBRATOR ----- VE1BFL



This calibrator is fitted into my HWS with its output attached to point M on the HW8 PCB, but it can be used with any rig. When the base of the 2N3866 is connected to pin 3 on the CD4024AE, output is obtained on the exact band edge and at each 7.8125KHz increment upwards throughout the band ( 7000KHz, 7007.8125KHz, 7015.6250KHz, and so on for the 7MHz band). Similarly, connection to pin 4 provides 15.625KHz increments, pin 5 31.250KHz increments, pin 6 62.500KHz increments, pin 9 125.00KHz increments, pin 11 250.00KHz increments, and pin 12 500.00KHz increments. Excellent marker signals are provided in the 21MHz range of the HW8, so the system should be usable up to at least 28MHz.

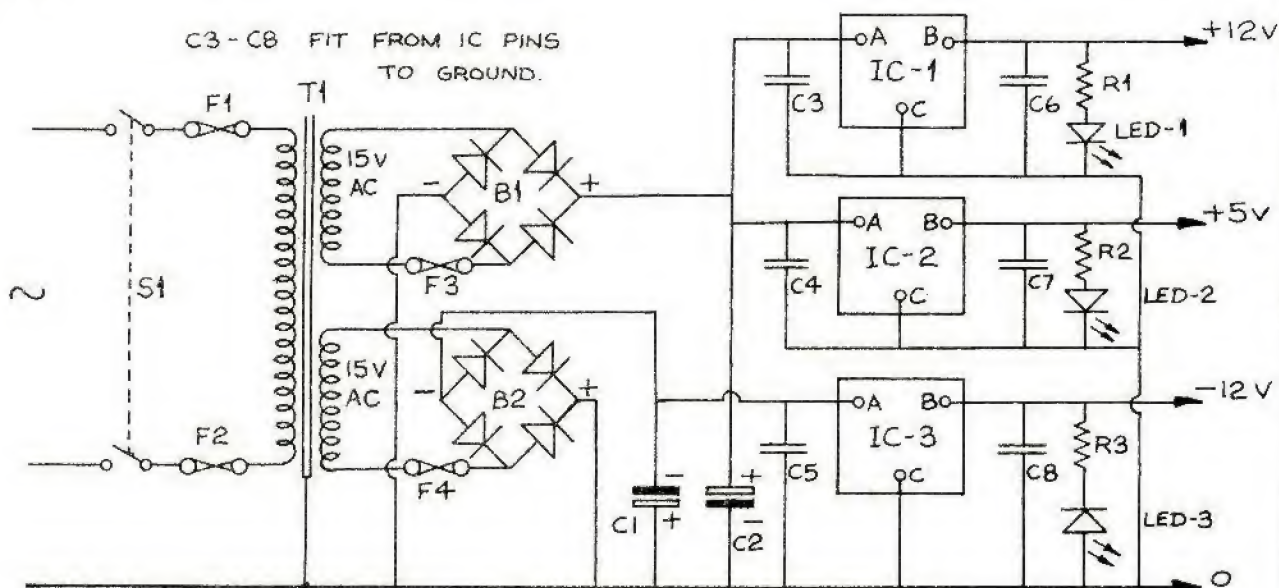


# Simple Speech Processor

Miles Salmon G2CKM

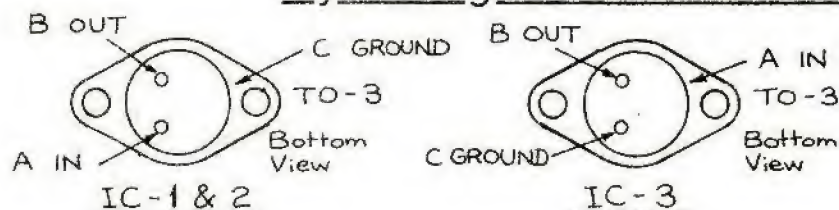
This circuit, originally from G3BMT, is used by Miles especially for /M SSB working. It enabled the operator to sit a couple of feet from the microphone and get on with construction or smoke his pipe! It is really a microphone head amplifier, giving extra audio "punch" to the signal, with a minimal amount of clipping from the two diodes. Most people say it does not reduce the audio quality, but increases the QRM by about two "S" points. The microphone may be fitted with the usual PTT.





## POWER PACK FOR Q.R.P. WORK

by George Burt GM30XX



### Parts List :

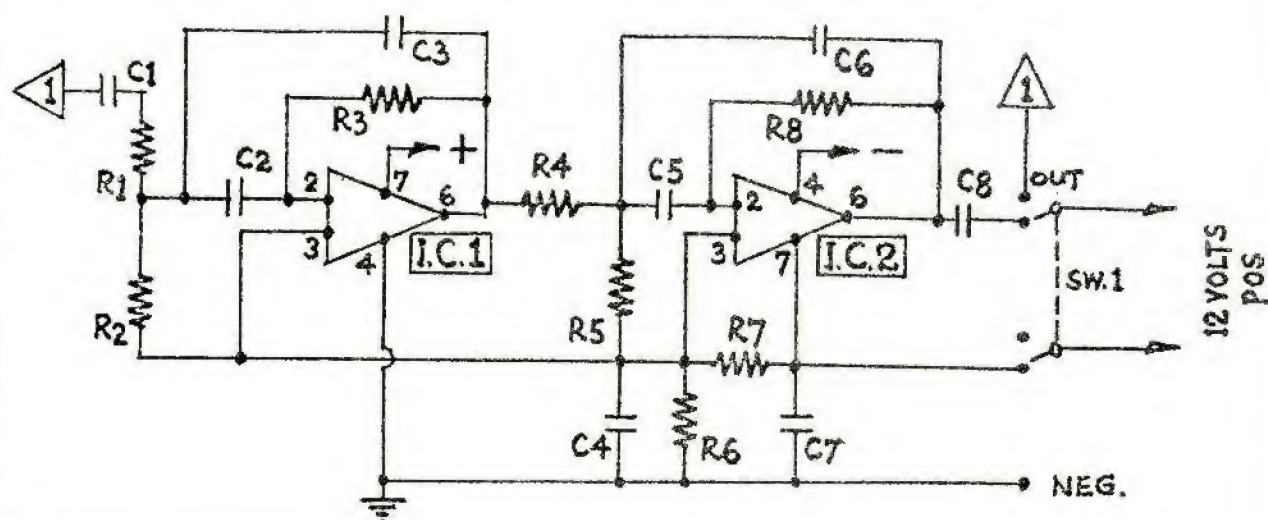
- |            |   |
|------------|---|
| T1         | - Low Voltage Transformer, 50VA, 240v Pri, 0-15v 0-15v Sec. |
| B1, B2     | - Bridge Rectifier, 100 PIV, 2 amp.                         |
| C1, C2     | - 3,000mfd, 50v wkg (as low as 30v wkg will do)             |
| C3, C4, C5 | - 0.22mfd, 30v wkg (Tant if possible)                       |
| C6, C7, C8 | - 0.47mfd, 30v wkg (Tant if possible)                       |
| R1, R3     | - 390 ohms, 1 watt (adjust values if LEDs other than        |
| R2         | - 100 ohms, 1 watt specified type are used)                 |
| LED 1      | - Colour RED (  |
| LED 2      | - Colour Orange( Panel Mtg type (Po 225 mW)                 |
| LED 3      | - Colour Blue (   |
| IC 1       | - LM340 +12v (  |
| IC 2       | - LM340 +5v ( National Semiconductor                        |
| IC 3       | - LM340 -12v (  |
| S1         | - Miniature DPST Toggle switch                              |
| F1 to F4   | - Panel Fuse-holders  |

NB - Heat Sinks are required for ICs 1 to 3.

Use of the ICs can give differing combinations of supply rails  
i.e. for all positive rails, reverse ground connections to B2 & C2  
and fit +Stab. IC.

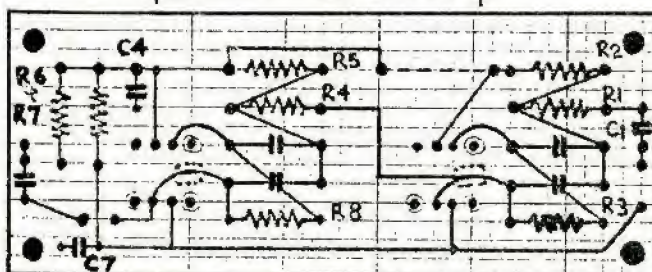
# AN ACTIVE FILTER • by • GM30XX

57



COMPONENTS SIDE

COPPER SIDE



This simple layout can be used as the selective stages in a direct conversion receiver or an add-on unit to improve the audio selectivity of any RX. When used with an existing RX, take care to keep the input level low or the effect of the filter will be lost.

Cut out the PCB template and stick it to the board. Centre punch all holes and remove template. Drill IC socket holes with a No. 64 drill, this makes it easier to use a Dalo pen around the IC holes. Drill component holes with a No. 60 drill and the mounting holes to suit 4BA or 6BA screws.

Now, using the IC holes as a guide, mark out the board with a Dalo pen, etch and fit components.

For best results in this circuit R1, R2, R3, R4, R5, R8, C2, C3, C5 and C6 should all be 1% tolerance components.

## COMPONENT VALUES:

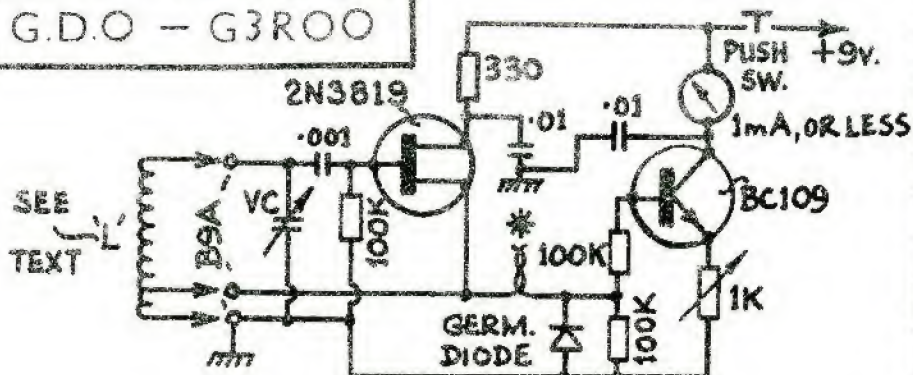
R1, R4 - 680K (1%)  
R2, R5 - 24K (1%)  
R3, R8 - 1.8M (1%)  
R6, R7 - 27K

C1, C8 - 0.01mfd  
C2, C3,  
C5, C6 - 0.001mfd, poly.  
C4 - 10mfd, 10v, Tant.  
C7 - 100mfd, 16v, Tant.

SW1 - DPDT  
IC1,  
IC2 - 741 Op Amp



## G.D.O. - G3ROO



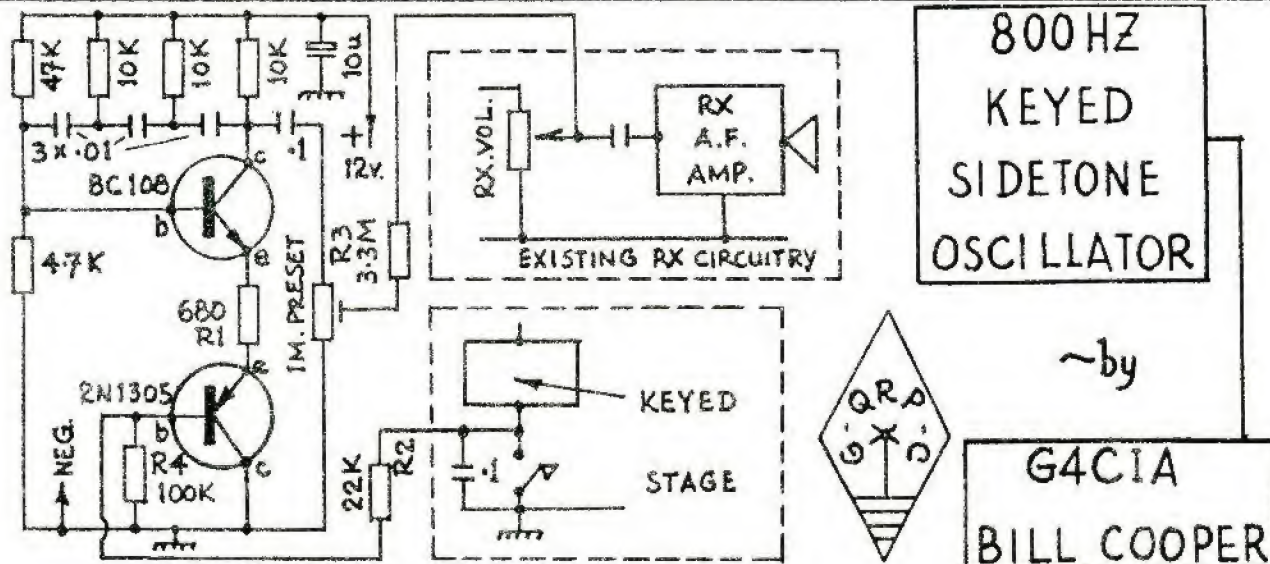
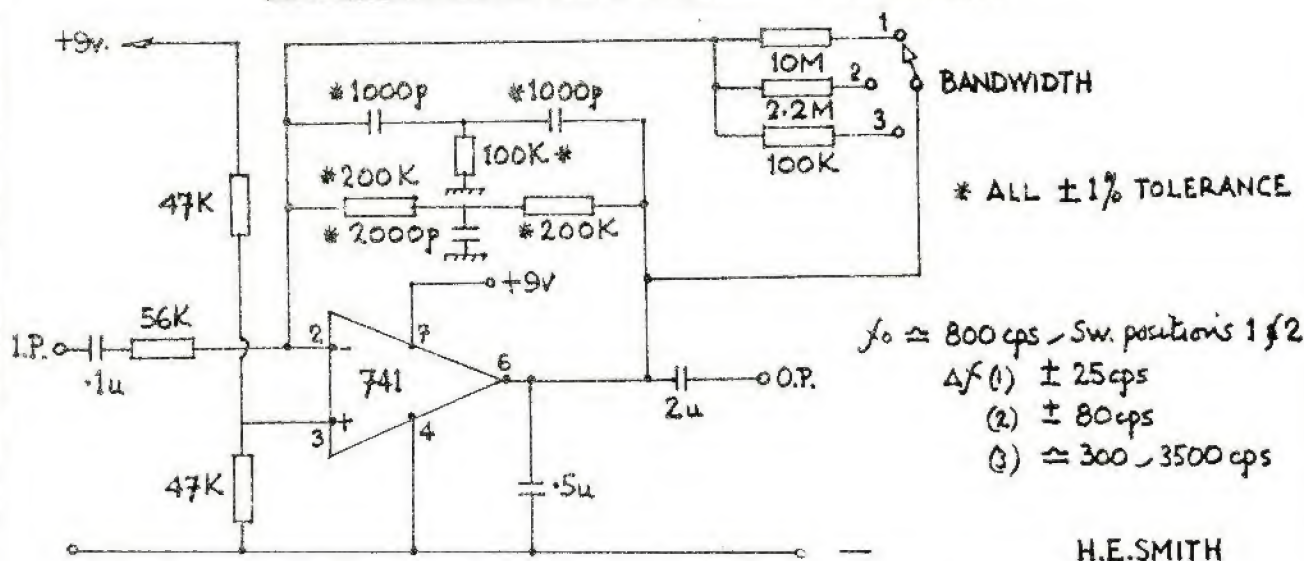
## NOTES

V.C. IS 'POLYCON',  
180p, EX. TRANS.  
RADIO. ———  
\* TWISTED LEAD  
COUPLING CAP, 1/2"

Having discovered that TOKO 13K coil formers (from Ambit, UK) fit B9A valve holders, a long sought-after piece of test equipment (a GDO) was the next construction project. Several circuits were tried and, as usual, the simplest proved to be the best.

A few points: The earthy end of the coil must be at the top, to reduce "pulling". Start with a tap ratio of about 5 : 1, on a coil covering about 8 to 15MHz. Then adjust the coupling to the detector circuit to give about 1/4 scale deflection on the meter. On other coils, the tap should be adjusted to give an indication of between 1/2 and 3/4 scale. This is no hardship, as winding coils on TOKO formers is very simple.

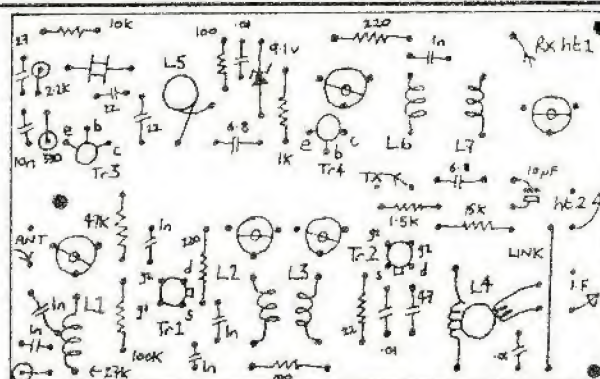
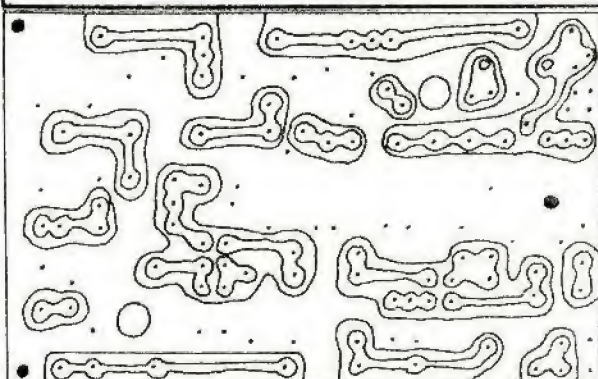
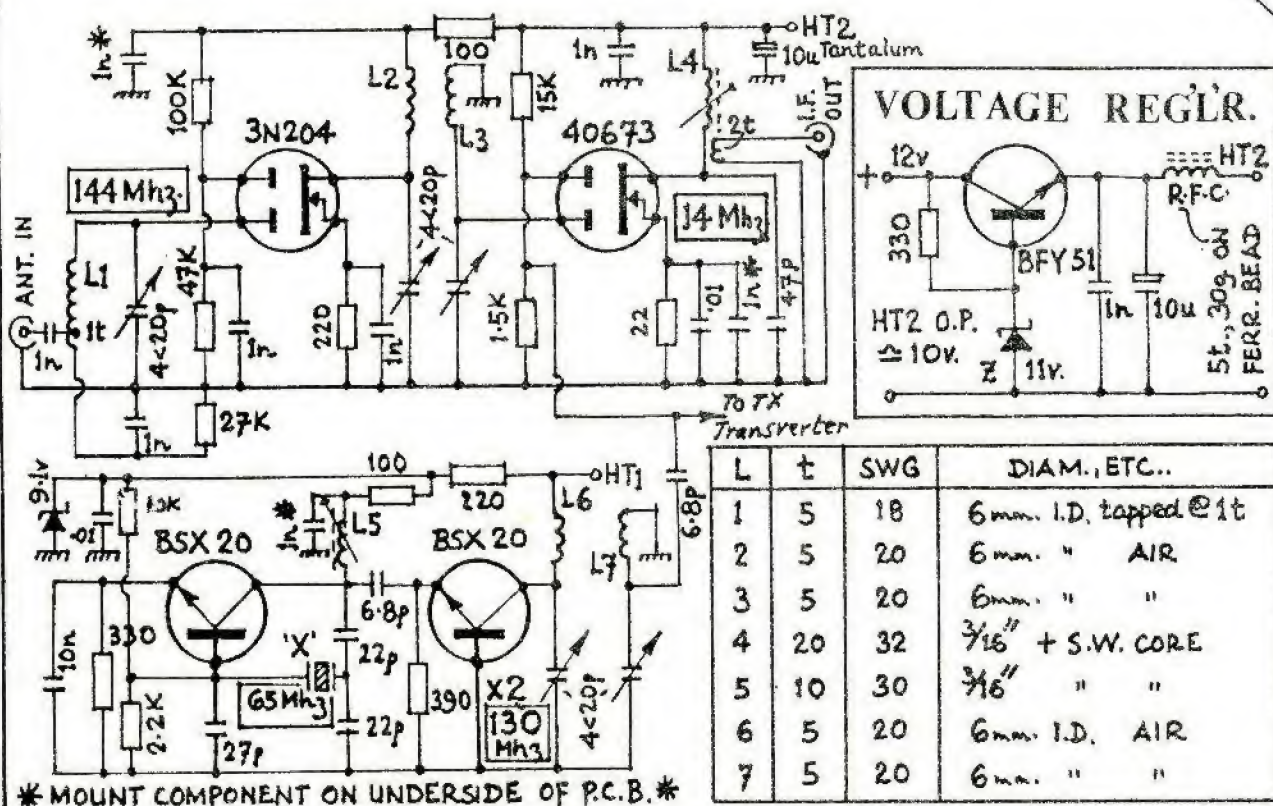
## ACTIVE AUDIO FILTER ——— G3iVF





# 144 MHz - 14 MHz CONVERTER - G4DHF

59



The converter to be described was designed so that DC TX/RX systems working on 14MHz could also be used to listen (and transmit) on 144MHz, thus providing a simple cheap and effective way of becoming active on VHF. The design is based on a circuit which was originally published in "Practical Wireless", October 1978 and has been extensively redesigned to fulfil the needs of the QRP enthusiast. The unit is housed in a small die-cast box, with the supply decoupled via bolt-in feed through capacitors. A short length of good quality co-ax connects between converter and RX, thus minimising any possible 14MHz breakthrough which may occur.

## NOTES:

- Crystal - 65MHz HC18/U or HC25/U, with miniature base.
- The 3N204 is a low noise version of the 40673.
- HT1 is permanently connected to the supply.
- HT2 is switched by the TX/RX switch so that the front end is disabled on transmit
- Bolt-type feed through capacitors are 1000pF.
- It is recommended that the voltage to HT2 be stabilised, as supply variations can cause L4 to de-tune slightly. Fig 2 shows a small regulator which will eliminate the problem.
- The four 20pF trimmers are miniature air dielectric PCB mounting types.





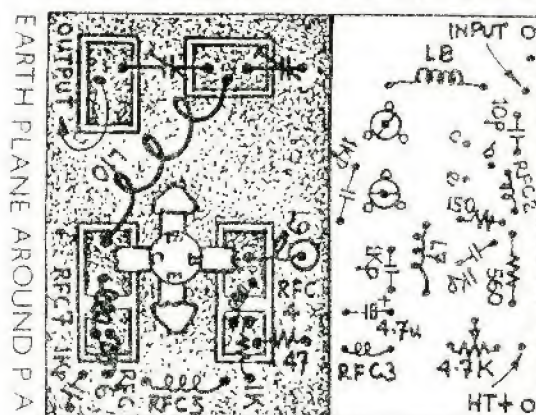
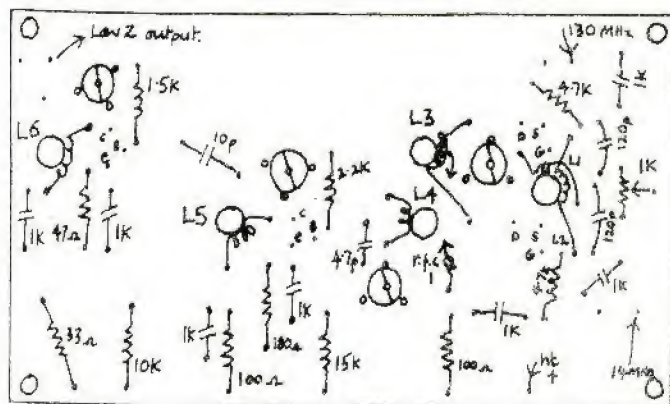
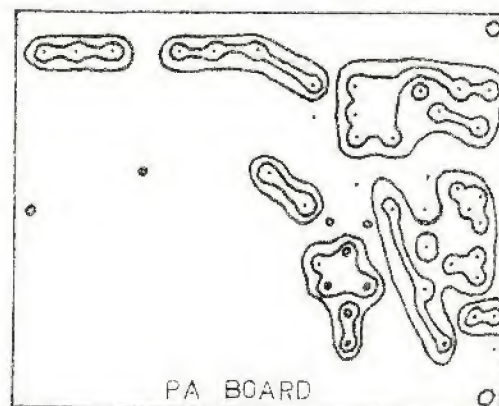
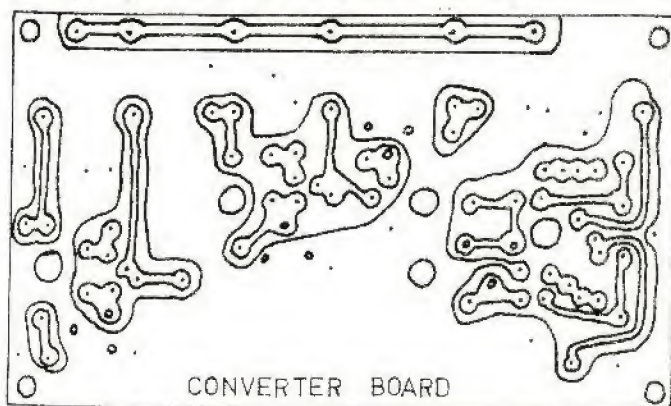


The low power mixer is based on a modified version of the DL6HA transverter (VHF Communications, August 1970) but incorporates FETs in the push-pull mixer. The 14MHz signal is coupled into the system by a low impedance winding over the coil, L2, which is padded on 14MHz by capacitors C1 & C2, and resonated by slug adjustment. This signal, together with the injected 130MHz, is fed out of phase to the gates of the push-pull mixer; the resultant 144MHz signal being resonated in L3 by C5. This is loosely coupled to coil L4 and then to a two stage Class A amplifier chain, producing 15-20mW output; this may seem very low but if bi-polar transistors were used in the mixer, the output would be much greater. So too would be the harmonic content. Remember that the difference between the two major mixing products (144/116MHz) is only 28MHz when using a 14MHz IF, as opposed to the 56MHz, when using the more conventional 28MHz IF. Even so, a two turn link over L6 will provide reliable contacts over several miles. 61

The PA section transistors have approx. 10dB and 12dB gain respectively. The Driver (2N3866) is fitted with a large clip-on heatsink as it normally operates at several degrees centigrade! The RFCs in the base circuits provide RF isolation from the bias supply, thus maximising those vital milliwatts. The output transistor (2N6080) is a strip-line device, producing a good two watts at the output.

Construction - Both PCBs, up to the final transistor, utilise single sided copper board. In the prototype, the top board was etched around the driver transistor to keep the emitter lead short and to reduce component de-tuning. However, there is no reason why this board cannot continue a full earth plane, provided that components are adequately insulated where necessary. Note that R14 & C16 are mounted underneath and soldered directly to the PCB, to keep the leads as short as possible. Although not included in the prototype, a small metal screen between each stage will help suppress harmonics. On the PA board, the final transistor is bolted to a piece of angled brass used as a heat-sink before the tabs are soldered into circuit. No excess heat is dissipated as the device runs well within its rated 4 watts output.

Alignment - Set VR1 at mid position, the slug of L2 half inserted, and C5 about 5% closed. About 3v of 130MHz, as supplied by the RX L.O., and 1/2 watt of 14MHz is applied to the ports, and L3 resonated on 144MHz by C5. The amplifier chain is tuned for maximum output. The 116MHz mixing product is detected on a wavemeter or second receiver and VR1 adjusted for minimum signal. Adjust the 14MHz coil for resonance and mixer linearity (indicated by the 2 metre signal quality). VR2 on the PA board is adjusted so that 1 to 1.5v appears above the emitter resistor R14. With the given bias network values, the PA should draw a standing current of 10 - 20mA.

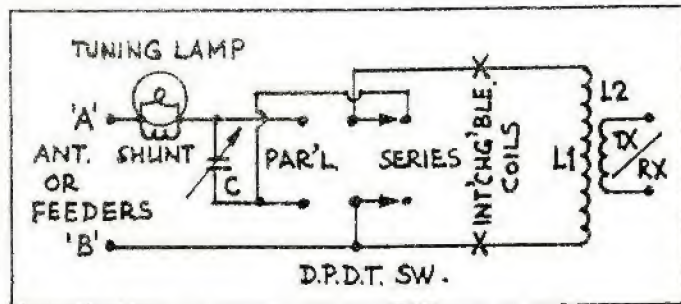




Rockonator ATU  
W9SCH

This thing will tune any tunable antenna or feed system I have ever tried but there is nothing new about it; I stole it from an old spark era receiver circuit!

I have used it extensively, especially for QRP, for 5 years with entirely good results. Upper harmonic attenuation is also satisfactory and effective.



Just connect an antenna system, (tuned feeders, antenna/ground, or almost any other type), to terminals A and B. Terminals X and Y go to the transmitter or receiver antenna relay, via a short piece of coax cable (or even lamp cord). If your antenna or feeders show a high impedance (hundreds of ohms) throw the DPDT switch to the left, parallel position; if low impedance (tens of ohms or less) put the switch to the right (series) position. Then tune C for maximum antenna current. Adjust the Pi-network or antenna coupling at the transmitter to obtain the desired DC power input. Keep all wiring short, direct and heavy.

You may build this gadget in almost any physical form you wish, providing you keep good insulation and L1/L2 its own diameter from large pieces of metal. C is any air spaced capacitor of 200pF or more (maximum). Keep this capacitor insulated from the metal box or chassis, if you use one. The DPDT switch should be of what we call the "knife" type, as the toggle or slide types often have poor insulation, excess internal capacitance, or both. (Switches of this type are readily available in parts shops on this side of the Atlantic and should be available over there too). The lamp and shunt for indicating maximum antenna current will depend on your output power. I use a 2 volt, 60mA pilot lamp for two to five watts QRP, and a 6 volt, 150mA lamp for "high power" (30 to 40 watts input). In each case the shunt consists of ten turns of almost any old coil wire (somewhere near 22 AWG/20SWG) wound around a 1/4" pencil, and then the pencil is removed. Most of the current goes through the shunt; only enough goes through the lamp to noticeably light it, thus little power is lost. (Rich folks might like a thermocouple ammeter instead, but this is a needless luxury).

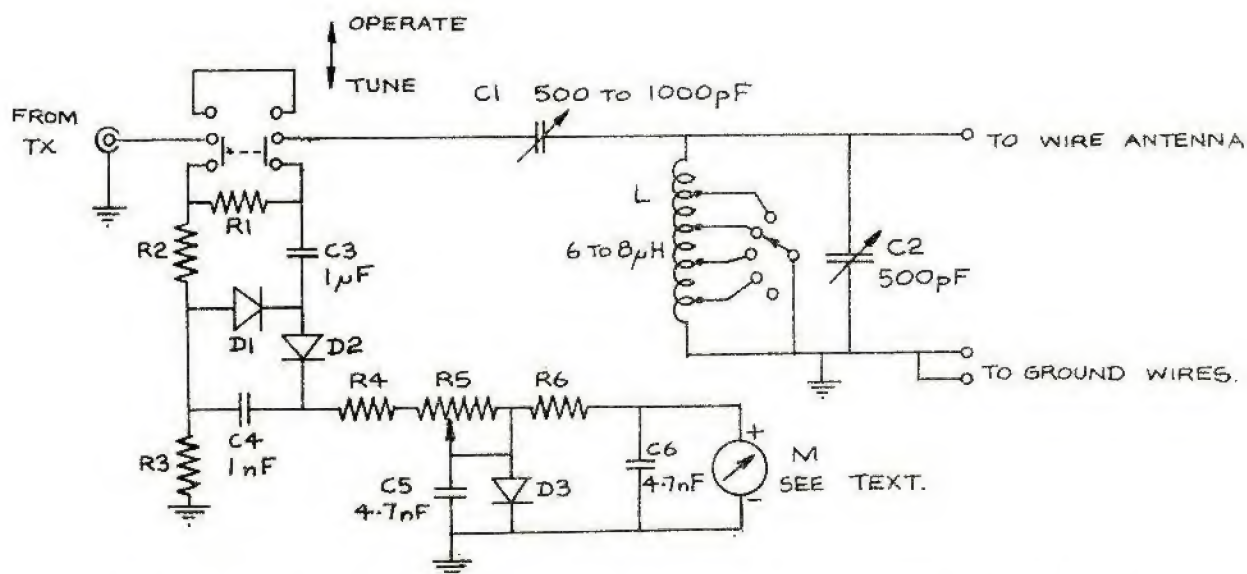
Rather than bother with coil switching, I use interchangeable coils, wound with what we call in the USA "bell wire", No. 18 or 20 wire insulated with a thick plastic coating. The coating spaces the turns, producing a high Q coil with little effort. All coils are close wound.

Some of our variety stores sell small plastic water tumblers very cheaply. These are small taper, an average diameter of about 2" and make handy coil formers where space is not at a premium. I use these for all but the 15 metre coil, which is on a half inch diameter plastic pill vial, obtained from a chain drug store (chemist shop!). The table below shows the suggested number of turns:

<u>Band</u>	<u>L1</u>	<u>L2</u>	<u>Former</u>
160	50	5	2 inch tumbler
80	25	3	ditto
40	10	2	ditto
20	5	2	ditto
15	5	1	1/2 inch pill vial

These values work well with my 100 feet centre fed "zepp", with 30 feet open wire feeders, (feeders tied together and tuned against ground for 160 metres). You may need to change them to suit your specific set-up but since this set-up also tuned a random number of wires I have tried from time to time, they cannot be too critical. There are many types of antenna tuner but I do not think you will find a more flexible or cheaper one. Try it and see for yourself...

## Ha-Jo Brandt DJ1ZB



$R1 = R2 = 47\ \Omega$  OR  $56\ \Omega$  OR  $68\ \Omega$

D1, D2 GERMANIUM DIODES

R3 - THIS RESISTOR MADE UP AS FOLLOWS:

2 x 100 $\Omega$ IN PARALLEL FOR	50 $\Omega$	INPUT	IMPEDANCE
2 x 120 $\Omega$ IN PARALLEL FOR	60 $\Omega$	"	"
2 x 150 $\Omega$ IN PARALLEL FOR	75 $\Omega$	"	"

D3 SILICON DIODE

R4, R6 - SEE TEXT

R5 VARIABLE RESISTOR (POTENTIOMETER) SEE TEXT

Simple Antenna Tuning Unit to match Random Wires to Transmitters  
requiring 50  $\Omega$  Load By DJ1ZB

KAS 3.7.1975

It has become common practice to design all transmitters for a 50 ohm load impedance, because coax fed antennas are less critical in respect to TVI and BCI. With QRP rigs however, these problems are less severe and for QRP portable operation the old-fashioned wire antennas are more practical than coax fed aeriels.

The simple unit shown in the diagram is capable of matching end-fed wires and the Windom antenna to 50 ohms, or to any other value, depending upon the resistor being used for R3. There is just one condition that must be met, the antenna impedance must be somewhat higher than the coax impedance.

The values for C1, C2 and L permit operation from 3.5 to 29MHz, for 160 metres they should be doubled. The coil switch must have at least five to eight positions for sufficient L variation.

For tuning indication, a resistive bridge has been incorporated. It may be omitted if a low power SWR meter is available. If R1 and R2 have the same value and the transformed antenna impedance has been made equal to R3, no voltage can be detected by the diode circuit D1/D2/C3/C4.



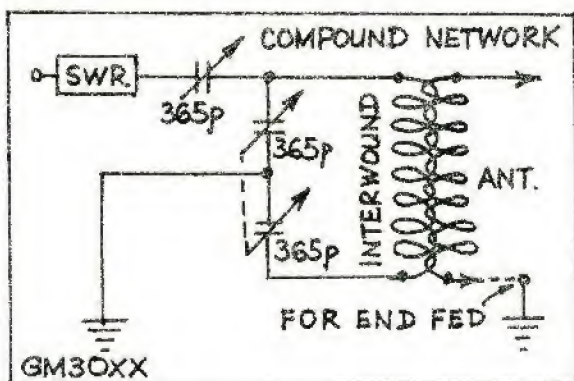
If one to two watt resistors are used for the bridge, QRP transmitters can be fed into the bridge at full power. Until the antenna is tuned, the resistive load of the bridge will help those transmitters which are sensitive to extreme mismatch.

M is a meter for phone volume indication. Because the specifications of these meters vary widely, no exact values can be given for the resistors R4, R5 and R6. R4 should be at least several Kilohms. R5 depends upon the sensitivity of the meter (25 to 100K), R6 is to act as a meter limiter in co-operation with the silicon diode D3. For those who like simplicity however, D3, C5 and R6 may be omitted (C5 is to avoid RF pick-up by D3).

To determine R6, it is replaced by a variable resistor (10K) and first set to minimum value. The RF is applied to the bridge with C1 set at minimum and R5 adjusted so that the meter reads full scale. If R6 is increased and R5 adjusted for maximum reading, a value will be reached which makes it impossible to increase the meter reading by decreasing R5, because the diode D3 will take over any additional current. The value of R6 is then measured and a fixed resistor of equal value soldered into the circuit.

For tuning, the slide switch is set to the "tune" position and RF from the transmitter fed to the bridge. R5 is adjusted for full meter reading, just before limiting. Then C1 & C2 are tuned and a suitable position of the coil switch is selected until the meter shows a dip. By further adjustment of C1 & C2, the meter reading can be made almost zero (a bad zero may indicate high harmonic level from the transmitter!). The exact null is very sharp. Finally, the slide switch is set to "operate" and the transmitter re-adjusted for maximum output.

If C2 should reach maximum or minimum value during tuning, the L switch must be adjusted. If C1 reaches maximum, the antenna impedance is too low to be tuned. The antenna length should be varied a little. If C1 reaches minimum value (possibly on the higher bands only), the antenna impedance is too high and antenna length adjustment should also help.



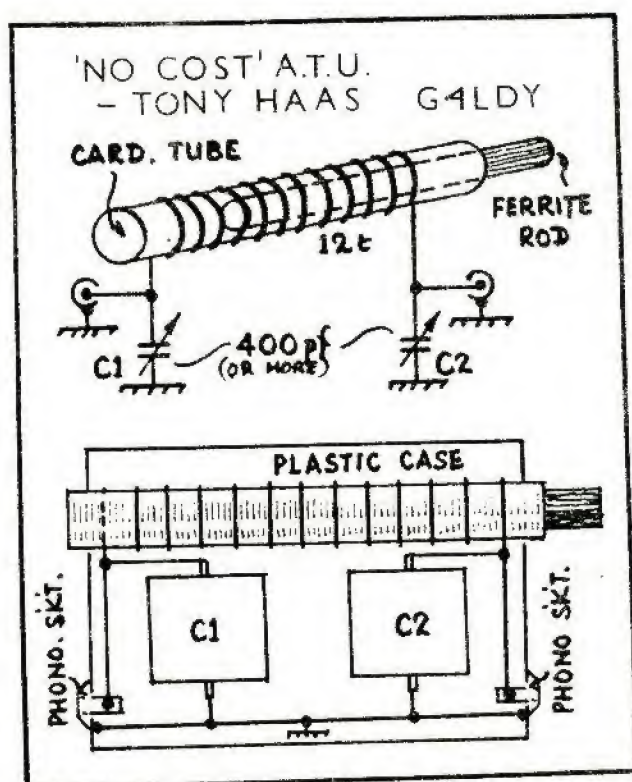
## QRP Z MATCH ATU

George Burt GM30XX

Having a centre fed zepp with a 44 foot top, trying to make an ATU to match it on all bands was quite a problem. Trying to adjust the taps for best match, with series or parallel tuning was not easy, but looking through an old handbook I came across a "Z" match which looked just what was needed.

L1 and L2 are wound on two inch plastic drain pipe and, using 4mm plugs and sockets, a set of coils were made for all bands. L1 is wound with 1.5mm solid wire and L2 with plastic covered flex. L2 is fully interleaved or layer wound with L1 and should be nearly the same number of turns. It is now possible to load the zepp up on all bands and it also works fine as an end fed system.

(For further details, refer to the third edition of the RSGB Handbook or Radio Communication, July 1976).



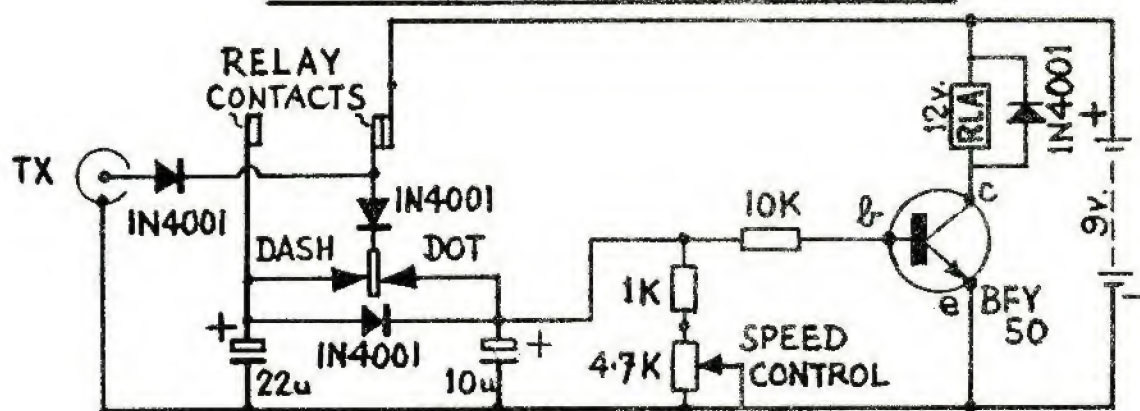
by Tony Haas - G4LDY

This QRP ATU was constructed from parts of old transistor radios yet works extremely well, having variable inductance and capacitance. Construction is as follows:-

The ferrite rod was stripped of original windings then wrapped with a piece of note-paper. When the paper was nearly into a tube, it was glued and finally rolled into the complete tube, leaving the ferrite rod a sliding fit. The coil was then wound round the tube and fitted into a plastic box along with two small capacitors from the old radios. The unit was then wired to diagram. Operation is straightforward like any other ATU, except that the inductance is completely variable by sliding the rod in and out of the tube.

I have used the ATU on 3.5 to 28MHz with very reasonable results. The first call to a station on 7MHz produced results using 10 feet of wire indoors, ending in a three way between stations in Hull and Dublin using 2 watts PEP. Subsequent tests on better aerials have proved very satisfactory and a 1 : 1 match can always be achieved.

### SIMPLE KEYS — GW3ZFY

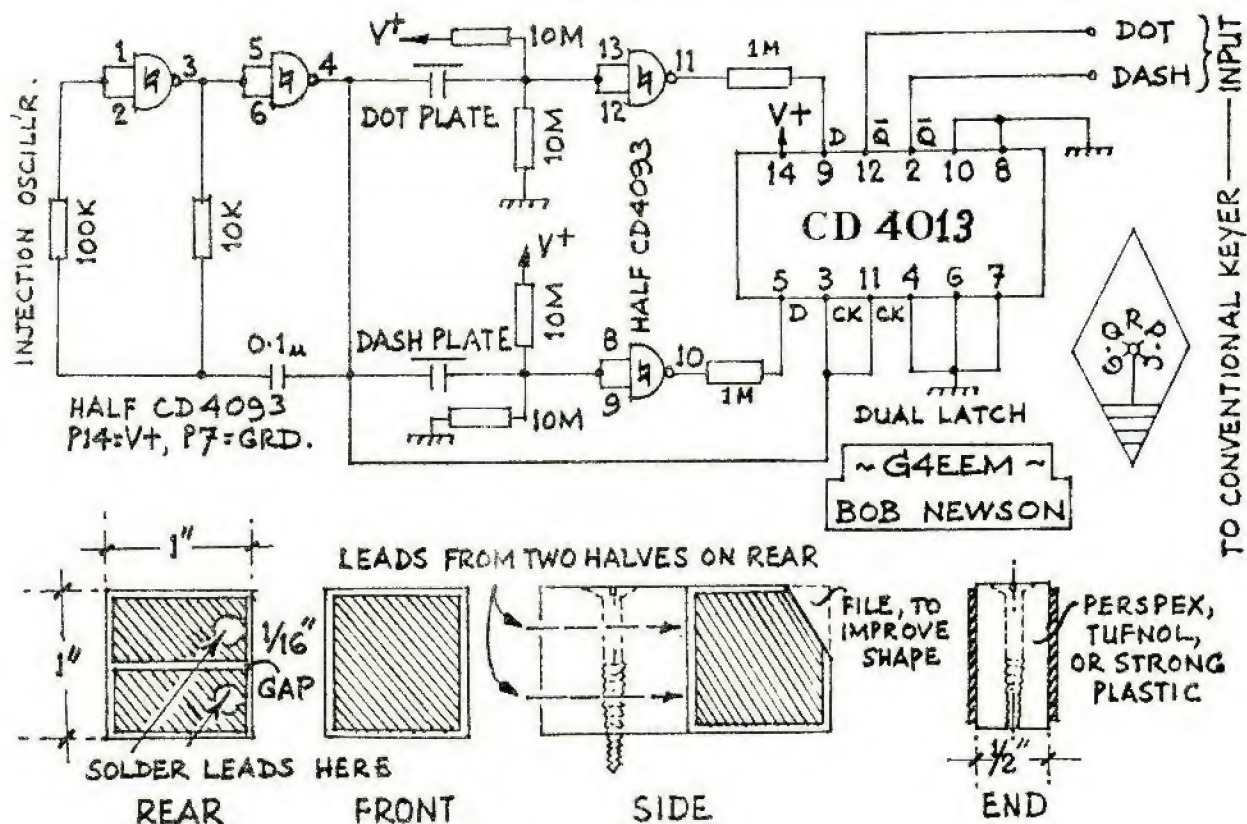


Another simple circuit from Don Benham, GW3ZFY - a single transistor and a light-acting relay make a useful basic keyer.



## Capacitance Toucher Paddler

Bob Newson G4EEM

Construction

The touch plates are made from standard 1/16" thick double-sided fibre-glass PCB material. A square inch of material is cut for each paddle and the side of each square has a 1/16" gap cut along its centre. This can easily be done by scribing with a sharp point, heating with a soldering iron and the copper in the gap should be easy to pick out when it is hot. Solder wires to the places shown in the sketch and tin coat all copper surfaces.

Actual dimensions, the spacing between the plates and the shape of the plastic part of the paddles are left very much to individual taste.

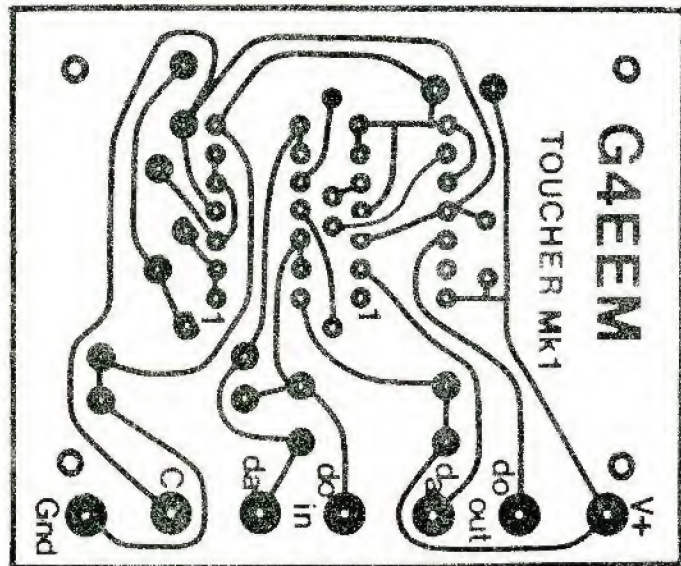
The circuit is powered from the keyer supply, 5 to 15 volts will do. Most mechanical paddles have their common connection grounded. For those which use V+ as common, the "Q" outputs of the flip-flop must be used (pins 1 & 3 of the 4013).

Operation

The capacitor, formed by the touch plate, constantly injects the oscillator frequency into the 4013 catch, holding the "Q" outputs high. When a plate is touched, the capacitance is effectively shorted to ground, causing the oscillator signal to cease. The "D" input of the 4013 goes high and the next clock pulse sends Q low. When both plates are touched, then both Q outputs go low and provide iambic keying for those keyers fitted with this facility.

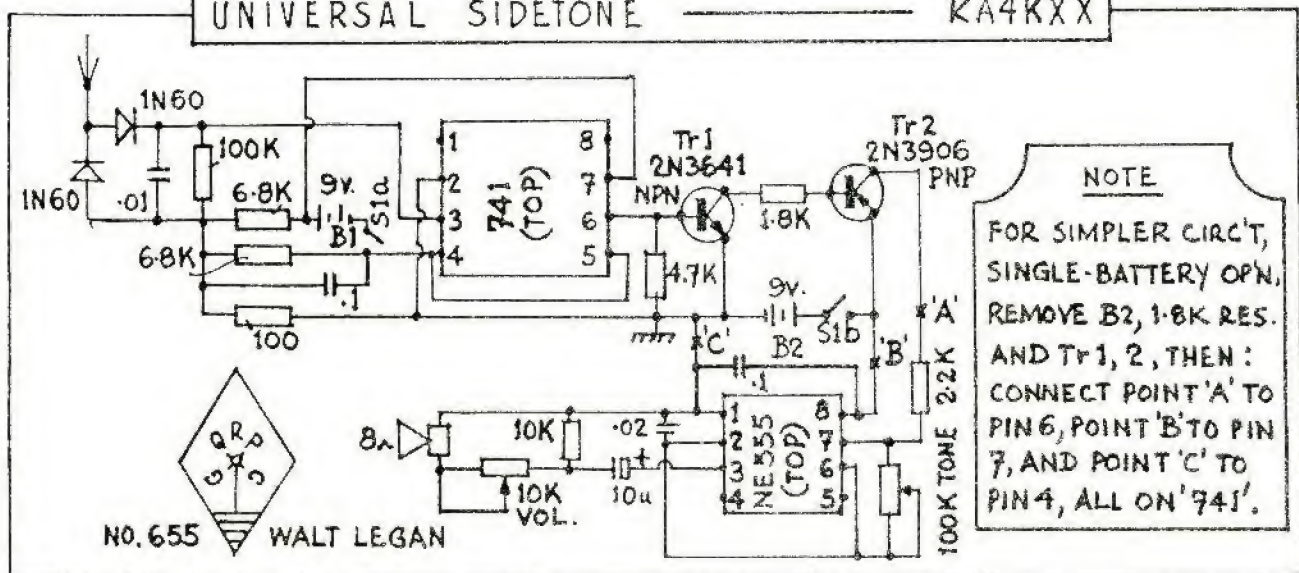
The designer wishes to add that this paddle is better to use than expensive mechanical types, once the "feel" has been obtained and the shape, height and position of the paddle has been found to suit individual requirements.





UNIVERSAL SIDETONE

KA4KXX



Here is a sensitive, portable, sidetone oscillator that can drive headphones or any speaker without a hard-wired connection to the transmitter. It requires no tuning for any HF band, and can be switched easily from transmitter to transmitter, so you can avoid having to include a sidetone generator in every transmitter you build. The tone is pleasant and free from thumps or clicks.

The circuit begins with a basic untuned voltage doubler RF rectifier. The induced voltage drives a DC op amplifier (see G4DYF, "SPRAT" 20 and G4EEM, "SPRAT" 21), which turns on the transistors to power the NE555 oscillator (similar to ARRL Electronics Data Book, page 114).

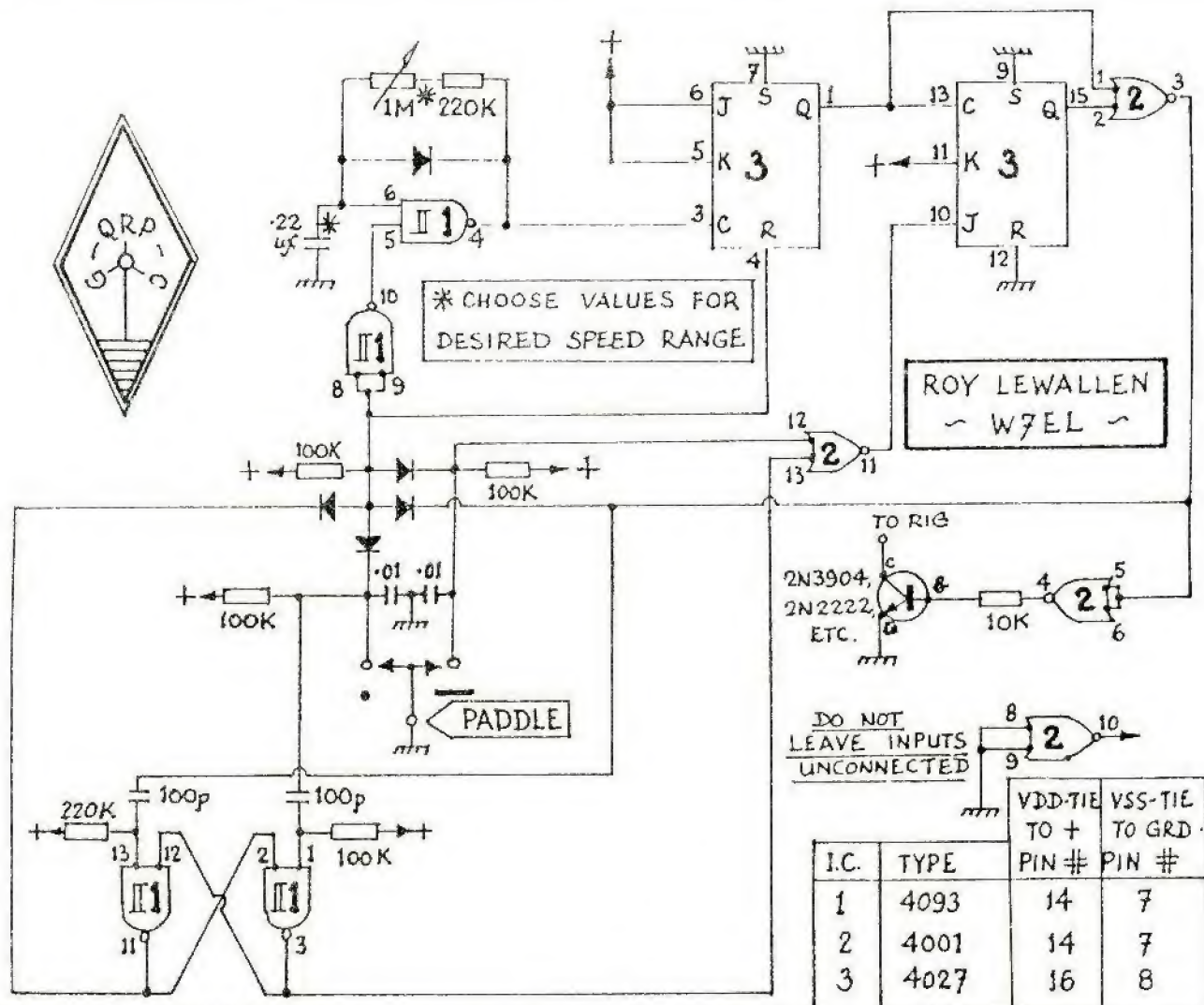
For an antenna, I use a 30" length of wire which goes through a small hole in the bottom of my 1 watt transmitter chassis. Inside, the end of the wire is wrapped one time around the inner conductor of the 50 ohm coax where it is exposed at the antenna jack connection. With anything over 1 watt, a few turns of antenna wire around the shielded coax outside the transmitter should be sufficient.

Actually, I have a home-made single FET dipmeter that will trigger the sidetone loud and clear, with as much as two inches separating the dip coil and the sidetone antenna, so I know that even the milliwatt boys can use it!

For a simpler circuit with single battery operation, remove B2, the 1.8K resistor and the transistors. Connect point A to pin 6, point B to pin 7 and point C to pin 4, all on the 741. Sensitivity will be reduced however.

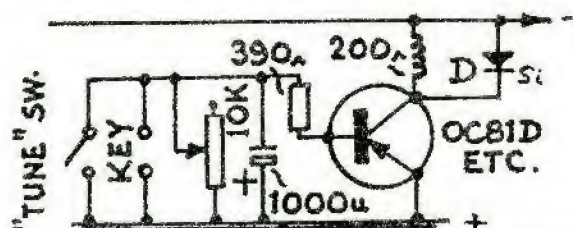


# 68 SIMPLE C-MOS KEYS FOR QRP RIGS



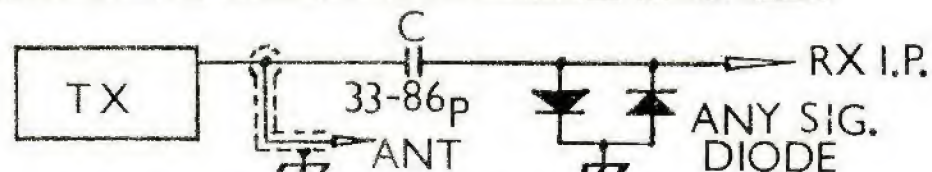
NOTES: (1) Basic design (in RTL) by G.D.Young, VE7BFB, in "Ham Radio", Nov. 1969  
(2) All diodes are silicon. (3) Do not substitute any type of master/slave flip-flop for the 4027. (4) The pos. supply voltage may be anything from 3 to 15 volts.

## SIMPLE, KEY-OPERATED CHANGE-OVER ~ G3YCC



With the values given a variable delay of 0 - 8 seconds is possible. I use a relay to mute the RX, apply HT to the TX, change over the antenna, etc.  
(use npn type for + line use)

## SIMPLEST T-R SWITCH ..... G3RJV



*C = smallest value for full A.F. output*



## Part 1 - Double balanced mixer and receiver muting.

One great problem of the HW7 receiver is its sensitivity to direct AM demodulation. This can be reduced by replacing the dual gate FET mixer with a double balanced IC mixer, which largely cancels out the detected AM. Fig 1 shows the IC mixer and its circuitry, which is placed on a small PCB (Board No. 1) and attached to the inner right side of the HW7 cabinet. The IC chosen can be operated asymmetrically on all three ports, so no balancing devices are needed for signal and oscillator input (as in a QST Jan 1974 circuit). Current consumption is also lower than with comparable devices such as the Plessey types SL640/641. The resistor value between pins 2 & 3 is a compromise between sensitivity and large-signal handling capabilities. An RF amplifier before the mixer has been found unnecessary.

Before wiring the IC mixer into the HW7 board, the dual gate FET and its gate 2 resistor divider must be removed. Also, additional holes must be drilled for the positive supply and the two ground leads. All connections are made with short self-supporting insulated wire.

When the IC mixer is ready for operation, the oscillator voltage at pin 7 of the IC should be measured by a diode RF voltmeter if possible. At 40 and 20 metres, the voltage should be up to 600mV. If the voltage is lower, capacitor C57 must be increased to 3.3 - 10pF. Experience from converting two HW7s has shown that, due to voltage variations at the collector of multiplier Q4, a fixed value for C57 cannot be given. On 15 metres, the oscillator voltage will always be much lower, usually 150 - 200mV. Finally, the 10K pot. is adjusted for best AM broadcast suppression.

Now to receiver muting during transmit. The IC mixer board also contains a separate resistor/diode combination, which will provide exact muting of the first AF amplifier within the CA 3035 audio IC as long as the antenna relay is in the transmit position. The wire bridge X - U on the HW7 circuit board must be removed and the combination wired as shown. As soon as the relay coil is energised, the first transistor in the CA 3035 IC will be driven into saturation. A clean CW monitor signal will be heard, even at high keying speeds.

Fig 2 shows the PCB of the IC mixer, and Fig 3 the positioning of its components. These improvements can also be applied to the Ten-Tec PM2 and PM3 QRP transceivers, which use similar circuitry to the HW7.

## Part 2 - RIT and Oscillator Shift Compensation.

The difference between receive and transmit frequencies and the inability to independantly tune the RX, is likely to give more trouble in QSOs than the QRP power. Therefore, the RIT circuit of Fig 4 was developed. It also has provision to compensate for the difference between receive and transmit frequencies of the HW7 VFO due to the couplings in the circuit board layout.

Frequency shift is via a BB103 varactor diode which is coupled to the oscillator via a 22pF capacitor. The diode and its RC coupling network are built on a small PCB (Board No. 2) which is glued to the side of the oscillator coil. The 22pF capacitor is soldered, self-supporting, to the wire bridge "J" on the HW7 board.

Board No.3 which is mounted on the left inside of the HW7 cabinet contains all the components to generate the varactor voltage. The 50K RIT control is mounted on the front panel, left of the crystal holder. The RIT/SPOT switch is mounted above the RIT control, to the left of the PA tuning knob.

For transmit/receive switching, the antenna relay contacts are used within the RIT circuitry. To achieve this, the antenna output must be DC grounded by a RFC of 20 $\mu$ H or more. The RF cable to the RX input is already DC open circuit because of the 100pF capacitor at coil L1. If the antenna attenuator is also to be installed, a



separate DC blocking capacitor of 4.7nF will be added. To open the transmitter lead for DC, the two 1K resistors, R21 & R22, of the diode measuring circuit must be replaced by 22pF capacitors.

Referring to Fig 4, when receiving with the switch in the RIT position, the varactor voltage is dependant upon the zener diode voltage of 6.8v, the 22K resistor, the 50K pot. setting and the 10K resistor to ground via relay contacts 1 & 2. The varactor voltage is variable between 2 & 5v, giving plus or minus 1.5KHz deviation on 40m and correspondingly more on the higher bands. Frequency deviation by the RIT control is not symmetrical. Therefore, when switching to SPOT, a 12K resistor is switched in to get into the middle of the pulling range. (To achieve a more linear deviation, a constant current source must be used instead of the stabilised voltage).

During transmit, the varactor voltage is determined by the 22K resistor, the setting of the 50K pot. switched in for the band in use and the other 10K resistor to ground via relay contacts 2 & 3. Switching of the 50K pot. is done by using spare segments of the switch assembly (refer to page 12, detail 1-8A of the HW7 Assembly Manual).

Alignment Procedure:- Coupling the varactor to the oscillator will have detuned the VFO, so both oscillator coils must be re-set to the dial, (switch in SPOT position). To align the oscillator shift compensation circuit, plug the HW7 dummy load into the antenna jack and tune the VFO to the middle of the 40m band (use slight coupling) and tune to zero beat. Press the key and tune the HW7 PA. The tone in the separate RX will change and must be re-set to zero beat by the appropriate 50K pot. After releasing the key the RX tone will shift again but will return to zero beat after the antenna relay has gone over to the receive position. The 20m & 15m band potentiometers must then be re-aligned in the same way.

Remember that the internal oscillator shift of the HW7 depends on the setting of the multiplier (Q4) tank circuits so, after any readjustment of these stages, the oscillator shift compensation must also be checked.

Tuning the HW7 will now be simple but accurate. To tune to a calling CW station, switch to SPOT and tune the VFO dial to zero beat. Then switch to RIT and adjust the RIT control for a convenient note. When the key is pressed, you will be exactly on the frequency of the calling station. If QRM occurs, the RIT control can change the beat note (or beat side) without altering the transmitter frequency.

To tune a SSB station, switch to SPOT, tune the VFO dial to the sideband in use, then switch to RIT and adjust the RIT control for clear speech.

Figs 5 & 6 show the PCBs for the varactor and RIT control circuits, while Figs 7 & 8 show the positioning of the components on them.

### Part 3 - Receiver Antenna Attenuator

Portable QRP rigs are often used with very high antennas, not normally available to the city-dwelling amateur. Although such antennas are excellent on transmit, their receiving energy is so high that it can overload even the double-balanced mixer recommended in Part 1. An attenuator must therefore be used in the receiver input lead. The author prefers T or Pi section attenuators to simple potentiometer controls because the match will remain constant on both sides independantly of the attenuation and the resonance of the antennas and antenna tuners will not change.

Fig 9 shows a 0 - 10 - 20 - 30dB step attenuator for  $Z = 50$  ohms, and its wiring around a 4 x 3 contact switch. The third position is not used for switching but as supports for the cable shield and the 4.7nF capacitor which is needed for DC blocking of the HW7 RIT circuitry. The switch can be mounted on the rear panel of the HW7 cabinet over the antenna jack. The RF cable to the receiver input is removed from points Q & S and soldered to the attenuator output. A new cable is needed to connect Q & S to the attenuator input. (continued on page 76)

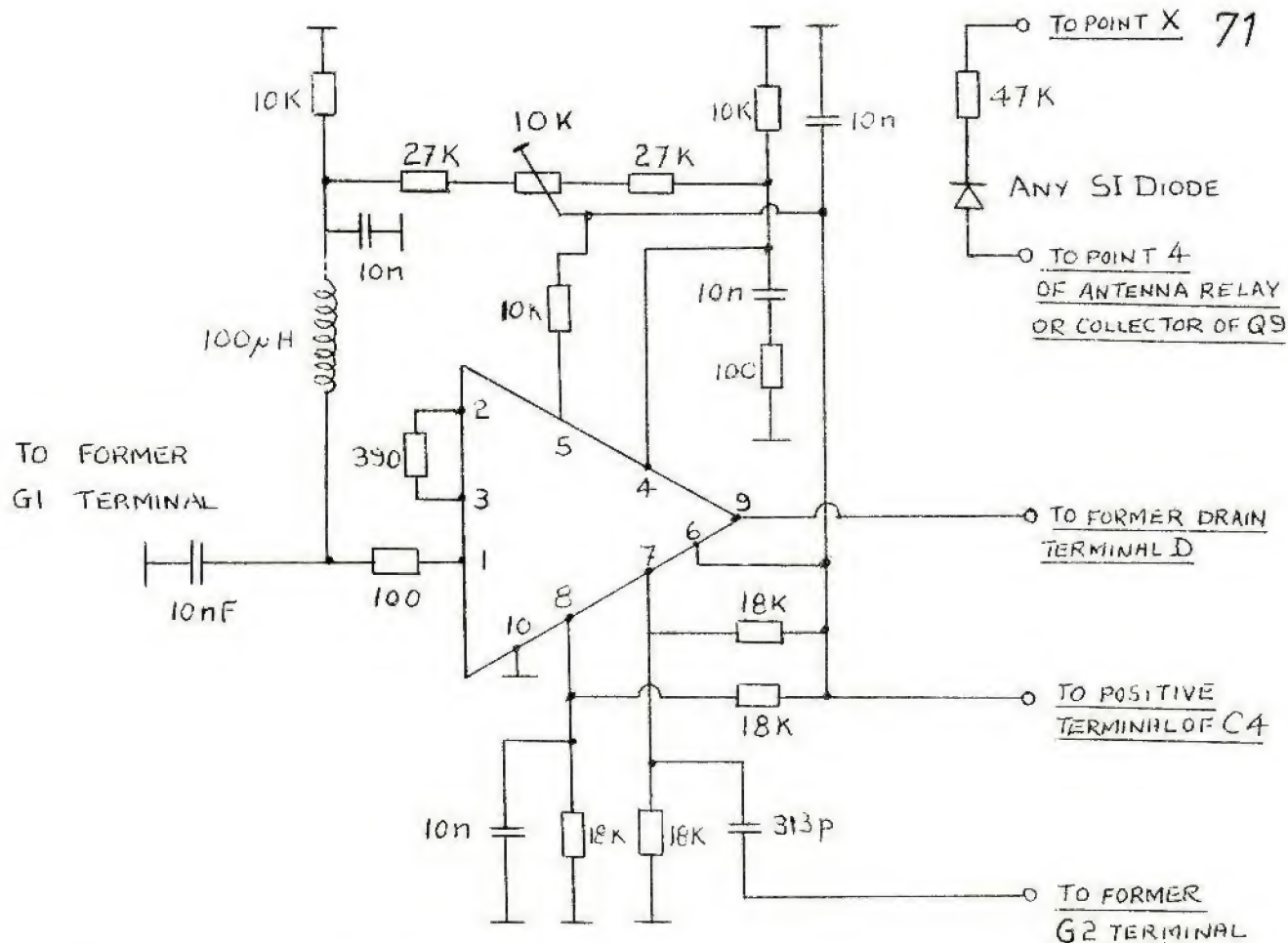
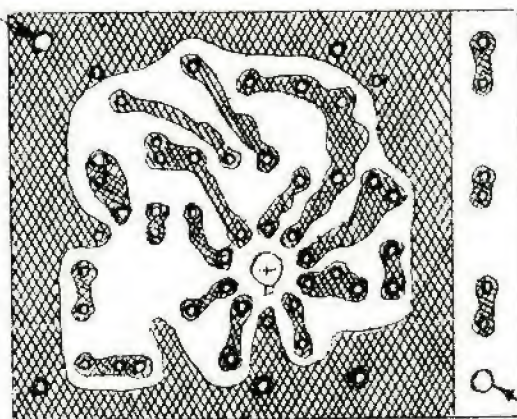


Fig 1 - Replacement of the Dual Gate FET Mixer by a Symmetrical IC Mixer.  
Types: uA769 (Fairchild), MC1496 or 1596 (Motorola) or SG1496,  
SG1596, LM1496, LM1596.

Screw Hole



Collector Q9

+(C4)

Screw

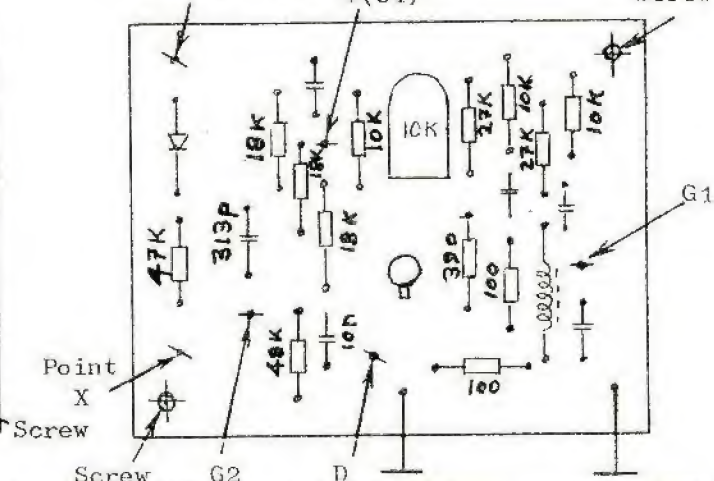


Fig 2 - Board 1 (Copper side)

Fig 3 - Board 1 (Component side)

IC = MC1496 (Nose of case at pin 10 grounded)



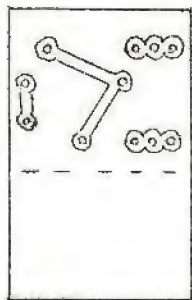
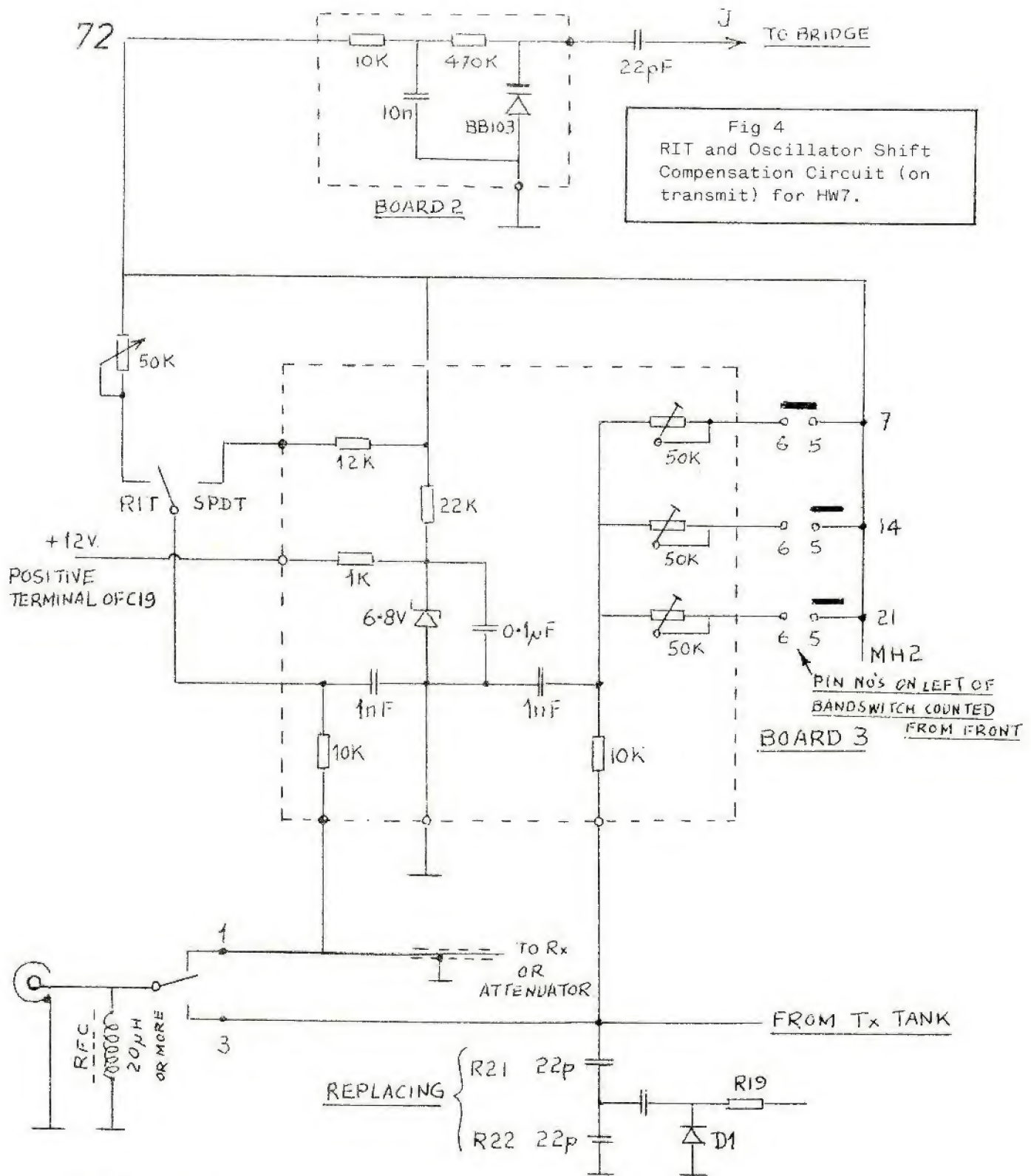


Fig 5 - Varactor Circuit  
Board 2 (Copper side)

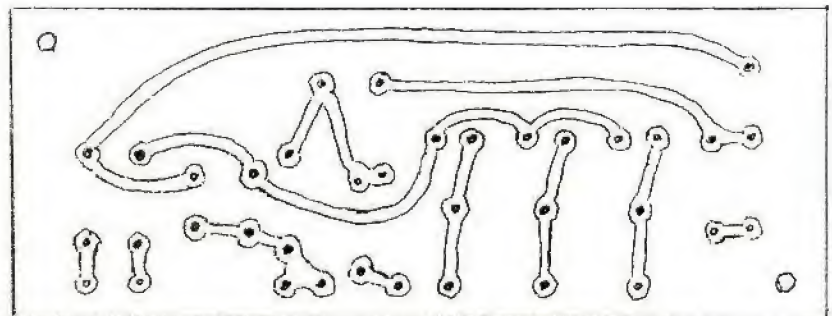


Fig 6 - RIT Control Circuit. Board 3 (Copper side)

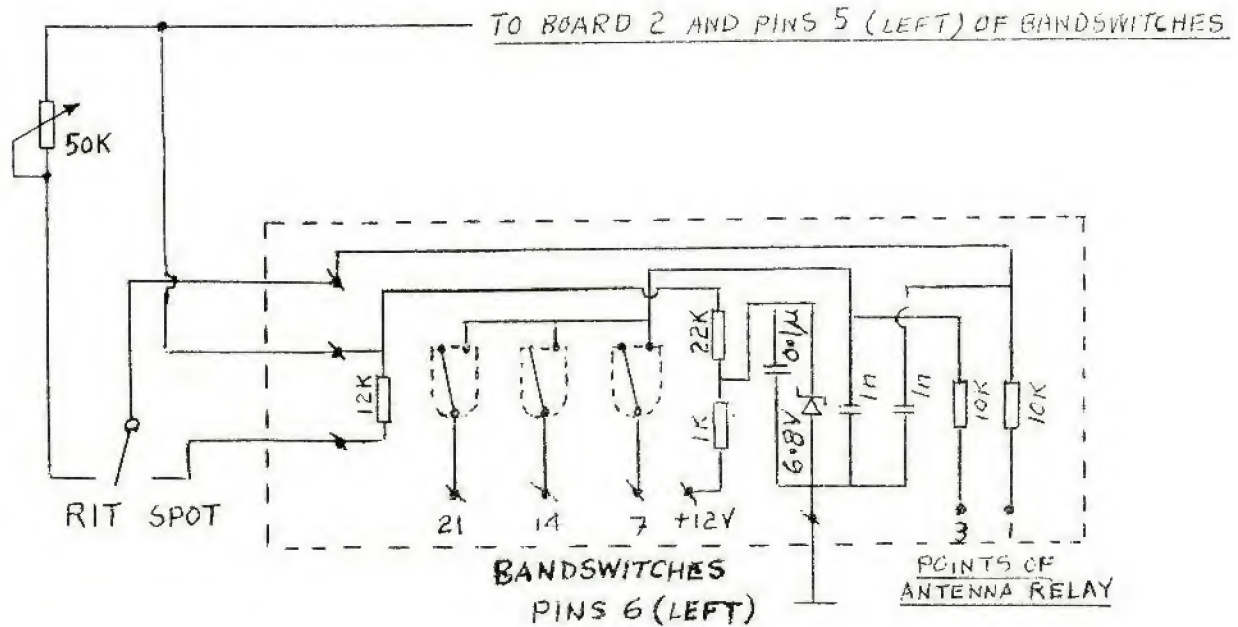
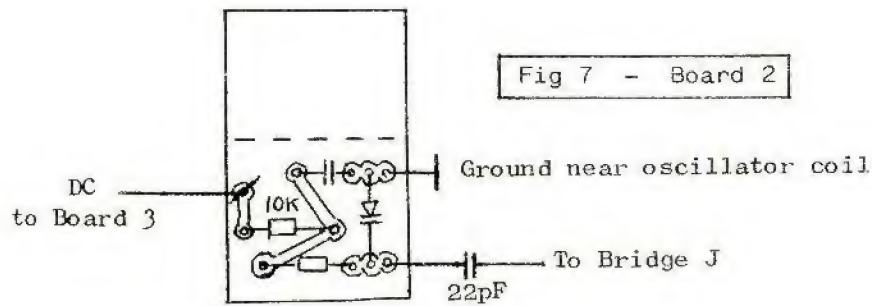


Fig 8 - Board 3. Component side and Associated Circuitry

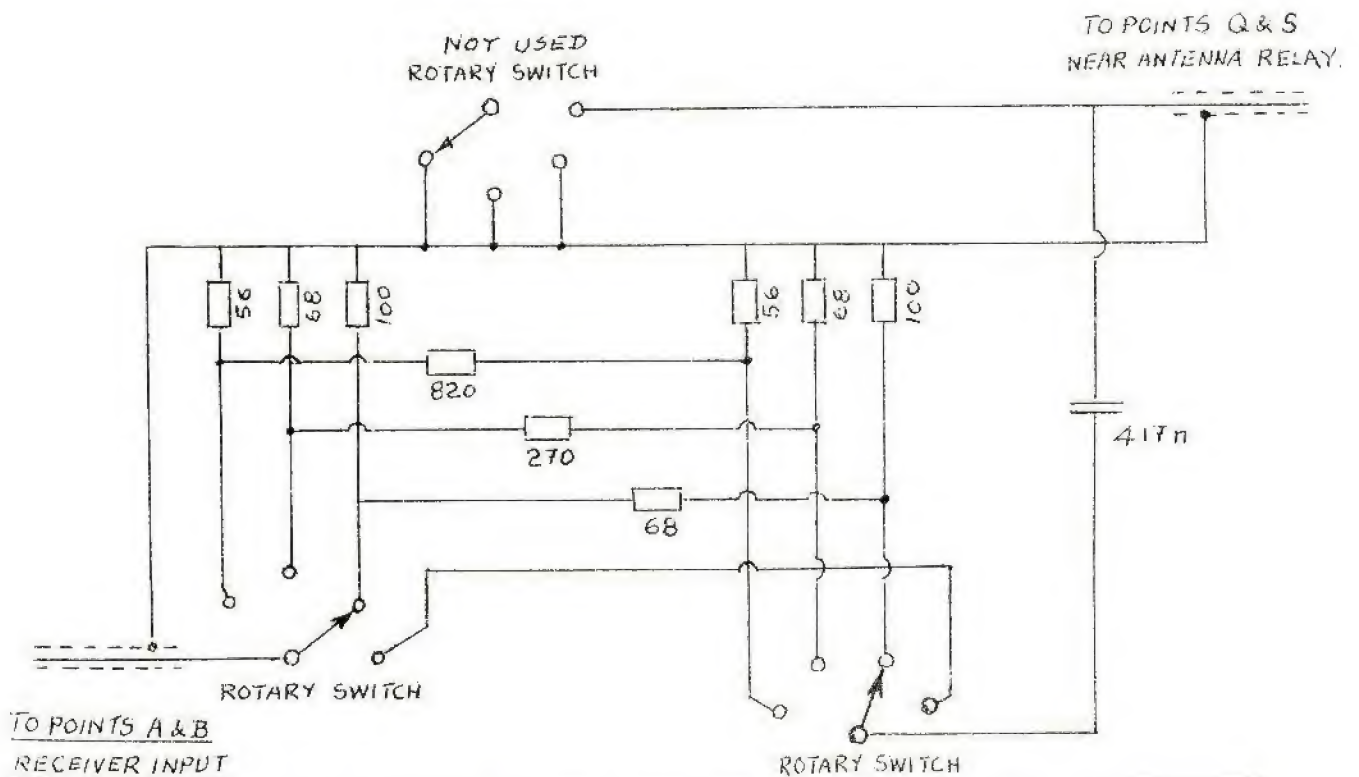


Fig 9 - Receiver Attenuator Circuit. 0 - 30dB for HW7 (and other receivers)



The junction of the two cable shields on the switch should not be grounded.

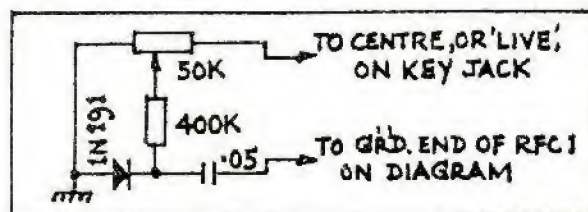
This type of attenuator is also used by the author at the antenna input of his O-T-2 FET regenerative receiver.

## Simple HW7 Modifications

## G5BIU and G2FWA

### 1. Receiver Incremental Tuning

50K pot.  
Diode (1N191 or similar)  
400K ¼ watt resistor



The 50K pot is mounted on the front panel, centred between the meter and the crystal socket. The off-set is about 0 - 850Hz, very useful in combination with the CWF-2BX filter. It is necessary to check the calibration after installation. To vary the amount of off-set, change the value of the resistor.

### 2. Full Break-in

To obtain full break-in operation, simply remove C19, the 25mfd electrolytic capacitor. The keying relay can follow 20 - 25 words per minute CW without trouble. (It is a bit noisy though).

### 3. Mains Hum

Mains hum or buzz can be a major problem. On one band the ground connections had to be on, while on another band they had to be off! The mains supply was disconnected in favour of a 12 volt accumulator.

### 4. Attenuator

An attenuator in the aerial input (element across input, coax core to slider) helped in some cases of breakthrough. Attenuators seem to reduce unwanted signals (i.e. in cases of cross-modulation) where the unwanted signal is not on the actual receive frequency, before wanted signals are reduced. I used a 300 ohm pot.

### 5. Receiver Peaking

The top right-hand panel control is far too sharp for receiver peaking. I have mounted the tuning capacitor on a bracket to make room for a Jackson Bros. reduction drive. A stiff wire (from a paper clip) has been soldered to the drive and serves as a pointer for the original panel markings.

### 6. Panel Lights

I purchased sub-miniature 6 volt panel lights (probably stereo indicator bulbs) and wired them in series across the 12 volt supply. One bulb was fixed to the sub-panel behind and at the top of the dial, while the other was arranged to side-illuminate the meter. The HW7 looks much more "alive" with a dial and panel light which also serve as an indicator that the transceiver is switched on. The dial light was held in place by adhesive (Araldite) and the bolt on the right side of the meter holds the bulb and provides the negative grounding for the two series bulbs.

Adding 80 metres to the PM3A is a fairly simple operation if the following sequence is carried out:-

- CAUTION:- (1) Before attempting the modifications, ensure that you have the correct double-ended hexagon trimming tool to re-align the VFO.  
(2) When modifying the front panel switch wiring, take great care to avoid damaging the dial drive cord by touching it with a soldering iron.

### Converting the receiver to 80 metres operation:-

Disconnect the 12v leads to the On/Off switch, solder them together, tape them up and tuck them out of the way. If desired, fit an On/Off switch in the 12v positive lead between the battery and the battery plug.

Using the two wafers of the original On/Off switch, connect the contacts as shown in Fig 2. Use the ON position for 3.5MHz and the OFF position for 7/14MHz. On completion of the wiring, set the switches for 7MHz operation and adjust the lower slug in the VFO coil screening can (reached by passing the small end of the trimming tool through the other slug) to restore the 7MHz calibration. The extra wiring capacitance may have shifted the calibration by several hundred KHz.

Next switch the old On/Off switch to its 3.5MHz (ON) position, setting the receiver RF peaking control to maximum capacity. Signals should be audible. Adjust the upper core in the VFO coil can, using the other end of the trimming tool, until the 7MHz point corresponds to 3.5MHz. It will then be possible to tune over the 80 metre band. If the RF peaking control will not resonate on 3.5MHz, adjust the slug in the receiver mixing module (MX1) until it does peak. The coil/capacitor combinations are designed so that 14MHz resonance occurs at almost minimum capacity on the RF peaking control and 3.5MHz at almost maximum capacity. Note that for 3.5MHz operation, the left hand 40/20 wave-change switch must be in the 40 position.

### Transmitter conversion:-

To add a 3.5MHz transmit facility the TUNE/OPR switch must be converted into a DRIVE/PA change-over switch and an 80 metre Driver/PA board must be built. This board must be small enough to fit into the space above the existing HF band Driver/PA board, (TX2), and should be fitted with lugs to allow it to be attached to the brackets which support the board carrying the change-over relay and its delay circuit. Almost any low power Driver/PA circuit is suitable.

Fig 1 shows a simple circuit using two 2N3053 transistors which will produce a couple of watts. With this circuit, do not hold the key down for more than 15 seconds at a time, to avoid over-heating the PA transistors. The wiring of the ex-TUNE/OPR switch (which was only a shorting switch for the key and therefore of little use) is shown in Fig 1.

One bank of the switch is used to switch the 12 volt positive supply between the existing TX2 board and the new one. The second bank similarly switches the aerial. As only one board at a time can have 12 volts on it, the keying terminals of both boards can be permanently connected to the key jack and the drive inputs from the VFO buffer/doubler board (AC6) are also permanently connected to both boards.

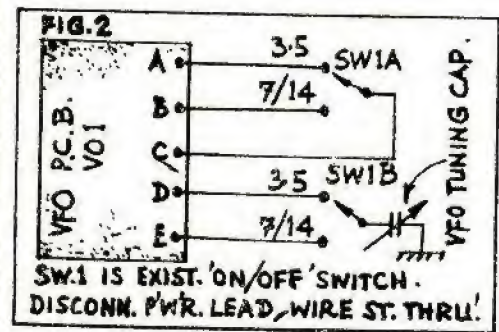
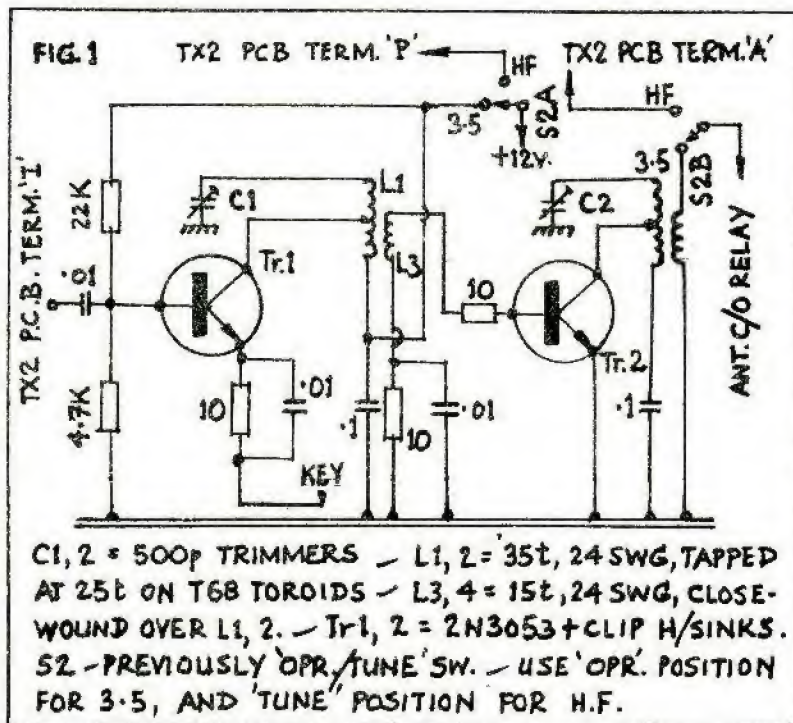
As the new Driver/PA has no front panel controls it is adjusted to give maximum drive into the station ATU with the case removed from the PM3A (now a PM3X!) and then left at these settings. If adjustment is made at 3.56MHz, the fall-off of power at either end of the CW band will be small. (continued overleaf)



While making these mods there are two others which are well worthwhile, the first of which I described some time ago in "The Milliwatt":-

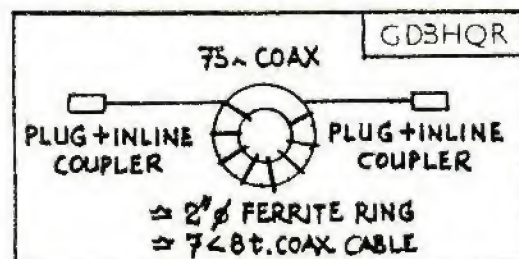
If a little heat is applied to the cement at the back of the front panel (using a soldering iron) it is possible to remove the Ten-Tec emblem, leaving two small holes. These can be enlarged sufficiently to take two midget sockets. The lead to the A terminal on the receiver mixer board can then be unsoldered and connected to one of these sockets, and a new lead run from the second socket to the A terminal on the board. It is then possible to either plug in a small link, giving direct connection as previously, or a series capacitor to reduce the aerial input. I use a Philips 3 - 30pF trimmer and, while not providing a complete cure, it eliminates a lot of the broadcast station "splash-over" problem encountered with this receiver.

The second modification is even simpler. Just wire a 120pF capacitor in series with the VFO tuning capacitor and re-align the receiver as described above. It now nicely covers the CW portion of each band, with much improved spread (which, however, is not quite linear).



## An HW7 Idea

GD3HQR



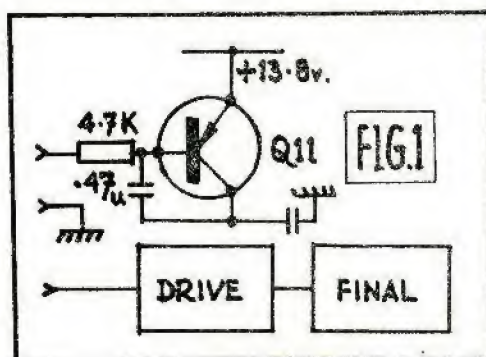
I was troubled recently when a local QRO station was breaking in on both my QRO rig and my HW7. In desperation I included in the coax to my rig, one of the anti-TVI devices I have for TV sets. This is just a length of 75 ohm coax toroidally wound on a ferrite ring. It reduced the local breakthrough by a good 50% on both rigs and in a later test I found that the hum on the HW7 from the Heathkit power supply had been reduced to almost zero! So since then I have left the device in circuit on both rigs. The ring is about 2" diameter, from Spacemark (Altrincham, U.K.).



## 77 HW8 Improvements Mike Perry PA3ASC

### Keying Waveform

The leading edge of the HW8 keyed RF waveform is very sharp and may be considered by some to be unacceptable. The transmitter is keyed by electronically switching the supply voltage to the buffer amplifier which drives the final PA. (Fig 1). The 2mfd capacitor discharges slowly when transistor Q11 is turned off, giving a slow trailing edge; but on turn-on, Q11 rapidly sucks charge out of this capacitor to give a fast leading edge. The remedy is to connect an additional 0.47mfd capacitor across the collector-base junction of Q11, thus slowing down the rise and decay of the collector voltage, due to the Miller effect. The capacitor is easily "back mounted" on the foil side of the printed circuit board.



### Reflected Power Measurement

The front panel meter of the HW8 can be used to measure reflected power, using the circuit of Fig 2, which is designed for a 50 ohm output. The principle is well known. Antenna current passes through a short piece of coax which is encircled by a high mu ferrite toroid, suitable for the frequencies involved. The toroid samples the current and the secondary winding develops a voltage, across R2, which should be about 300mV for full RF output (a good test to see if the ferrite is suitable). The braid acts as an electrostatic shield and must earthed at one end only. Voltage is sampled by R1 and R3 and added vectorially to the voltage across R2. The resultant voltage is rectified and fed to the meter via a switch.

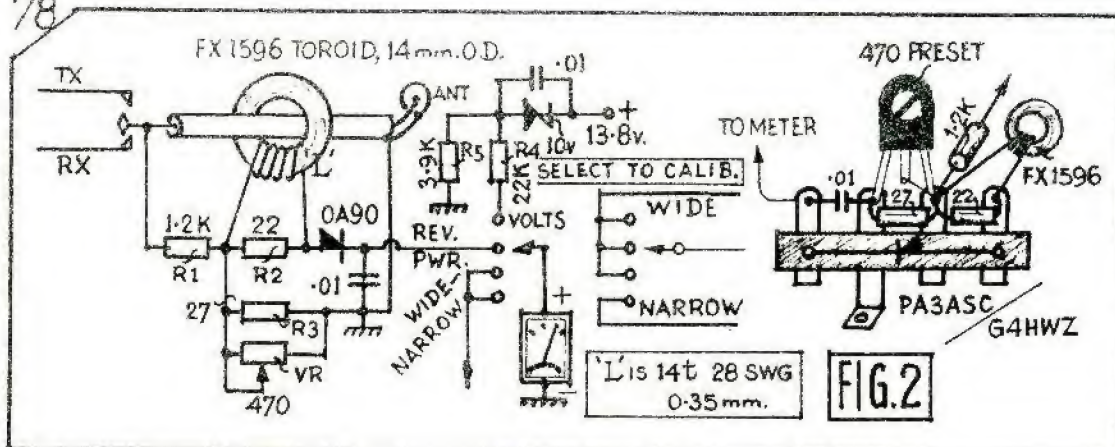
Installation is as follows: Remove the front panel and replace the audio bandwidth switch by a 3 pole 4 way switch of about 25mm diameter. Replace the front panel and re-connect the "RF Output" and "Wide/Narrow" functions. Remove the lead from the antenna socket to the relay.

Construct the SWR circuit on a tag-strip, keeping all the leads as short as possible (Fig 2). Drill a 3mm hole in the rear panel near the antenna socket and mount the tag-strip, remembering to make a good ground contact. Connect the lead from the diode to the switch. Wind 14 turns on to the toroid and slip it over the coax. (It may be necessary to remove the outer PVC sheath of the coax and insulate the toroid with a thin layer of tape). Ground the braid at the antenna socket and connect the relay to the antenna output. Connect up the toroid and R1 and set VR to maximum.

With the HW8 on dummy load, key the transmitter and tune for maximum output. Switch to "reflected power" and observe the meter reading. If the deflection is near maximum, reverse the leads from the toroid. Adjust VR for zero deflection.

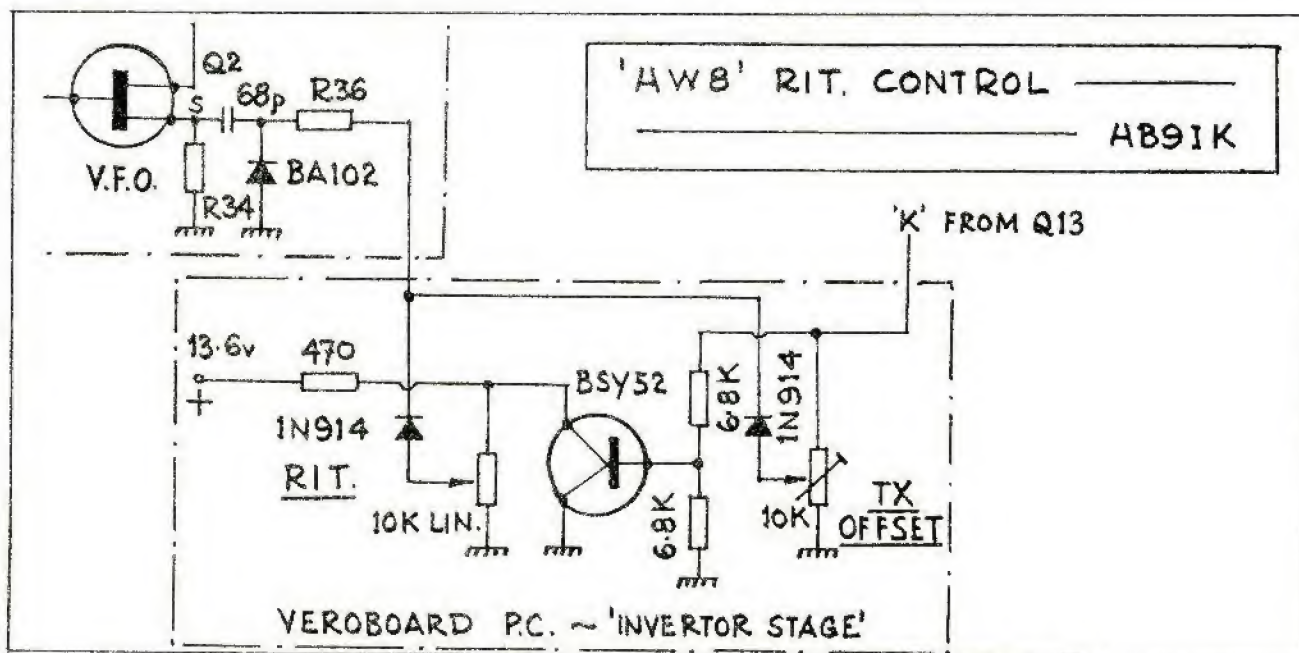
Due to stray capacitance, it may not be possible to obtain a complete null, but the meter deflection should be less than 1mm. Finally, if the voltage across R2 is too low, do not add more turns since this will upset the circuit performance; find a better ferrite ring.





Voltage Measurement

A zener diode and a resistor network may be used to check the supply voltage; useful for portable operation. Calibration is empirical. Components may be mounted on a tag-strip secured by one of the screws holding the meter in place.



Adding and Using RIT Control with the Heathkit HW8

1. Replace the switching diode and small capacitor in the VFO with a new 68pF and BA102 Varicap diode.
2. Break Lead K from Q13 to Q2 and insert polarity inverter stage with a BSY52 transistor, as shown.
3. Try to place the RIT control pot beneath the power meter, using a Philips mini pot on a bracket with the meter screws.
4. Mount the inverter stage, on Veroboard, inside the left of the cabinet.
5. Set the RIT control midway and adjust the TX offset trimpot to the same VFO frequency. Check the zero-beat of both RX and TX frequencies on a loosely-coupled receiver.
6. In operation, select either high side (USB) of RIT and tune the main dial from high to low, listening to the down-going beat signal, or vice versa.
7. Select the 750Hz beat note, corresponding with the built-in audio filter.
8. If the signal has QRM, try to use the other side of the RIT, but don't change the main dial tuning.
9. Following this procedure, your signal will be within the audio passband of the wanted station. Good Luck and CU QRP - Peter, HB9IK.



## Ten Metres with a Liner Two GM4HBM

The Liner 2 can be modified to work over the range 28.5 to 28.73MHz.

The modifications, worked out by the writer GM4FPR and GM8NXW, are as follows:-

### Receiver Modifications

1. Remove the chassis from the case. Unplug the 38.53 crystal from the 2m convertor PCB, (this disables 2m operation).
2. On the IF strip there is a screening can at the extreme right (brown core), and immediately to the right of it a test point (mixer output). Clip a short aerial to the test point. Using another RX, verify that 10m is "open". Switch on the Liner 2. Verify that 10m signals are being received. Disconnect the aerial.

### Transmitter Modifications (These involve building an outboard PA stage)

1. Obtain the G QRP C Data Sheet describing the 4W broadband linear PA. If in difficulty obtaining 2N5590 or the ferrite cores, these can be had from Modular Electronics and AJH Electronics respectively (see radio mags).
2. Construct the PA on copper-clad circuit board and bolt it through the heatsink into a metal box large enough to also house an antenna changeover relay and an RF output meter. The meter can be a 0 - 50uA type, or a tape recorder level meter. Before the components are mounted in the box, drill a hole for the meter, holes on the rear panel for an SO239 socket, a 3-pin DIN plug and a coaxial socket (and a hole for an LED indicator in the front panel).
3. Turn the Liner 2 chassis foil side upwards, with the front panel towards you. Remove the metal plate covering the 2m mixer board. Identify the mixer input test point in the mixer screening compartment at the extreme left and note its position; it will be the outboard PA drive point.
4. Apply power and press the PTT switch. Find any point on the board which is at 13.6v with the PTT switch pressed and at 0v with it released, and to which a connection can be soldered. This will become the power output point for the outboard PA and c/o relay.
5. Identify L25 on the main PCB. Short the inductor out with a wire link soldered across the coil tags. Locate the relay on the foil side of the PCB and short out the contacts on it which control the RIT, thus making RIT available on both send and receive.
6. Mount an aerial changeover relay (one from a Pye Vanguard is ideal) in the outboard PA box, adjacent to the SO239 socket.
7. Prepare an 18" length of single core screened cable (miniature 50 ohm coax is suitable) and an 18" length of twin core screened cable. Pass the single core cable through the small square hole in the rear panel of the Liner 2 and into the TX mixer compartment. Solder the inner to the mixer input test point and the screen to earth. Pass the two core lead through the same hole in the rear panel. Solder the end of one core to the mixer output test point (see receiver modification 2) and the other to the 13.6v point identified in the transmitter modification 4. Earth the screen of the cable. Determine the length of cable required to reach the outboard PA and cut both cables to this length. Terminate the single core cable inner on the outboard PA input terminal and earth the screen. Terminate the other lead in a DIN plug.
8. Make up a 50 turn pick-up coil on a small former and position it close to the output coil of the outboard PA, so that it will pick up RF. Wire the coil and a diode to the meter to provide an RF indicator circuit. Having done this, wire the anode of the LED in the PA box to the +13.6v supply and connect the cathode to earth via a 330 ohm resistor.
9. Connect the free end of the 50 ohm coaxial cable (connected to the mixer input



test point) to the PA RF input point (earth the screen at the PA end). Fit a 50 ohm dummy load to the outboard PA output socket. Apply power and note the RF output (either on the RF meter or on a power meter connected across the dummy load). The output should be at least one watt if a power meter is used. Switch off, disconnect the 50 ohm cable from the PA input and trim half an inch off it. Reconnect the cable, apply power and check the RF output. Repeat this process until the RF output peaks to a maximum, then use that length of 50 ohm coax to connect the Liner 2 to the outboard PA. (If a power meter is used, the output should be between 1 and 1.5 watts). Properly terminate the cable after measurements have been completed.

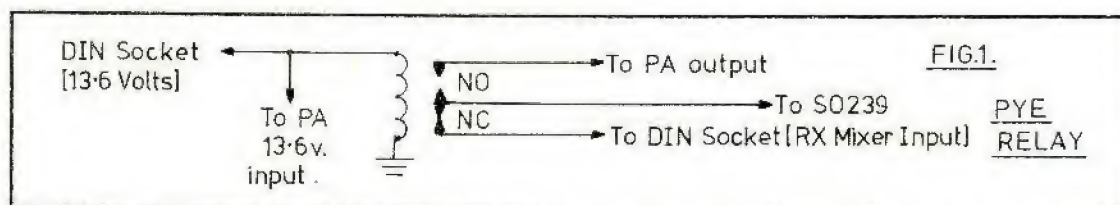
10. Wire up the send/receive relay as shown in Fig 1. Replace the TX board screen, remove the dummy load and connect an antenna to the PA.

#### Retaining Two Metre Operation

One can revert to 2m operation by replacing the 38.53MHz crystal and removing the shorting link from the relay in the Liner 2. GM4FPR has gone one better than this, however, by fitting a double-pole changeover switch on the rear of the Liner 2 chassis. It switches the crystal in or out of circuit and makes or breaks the link across the relay. The link across L25 is left in place permanently as it does not appear to alter the Liner 2 performance.

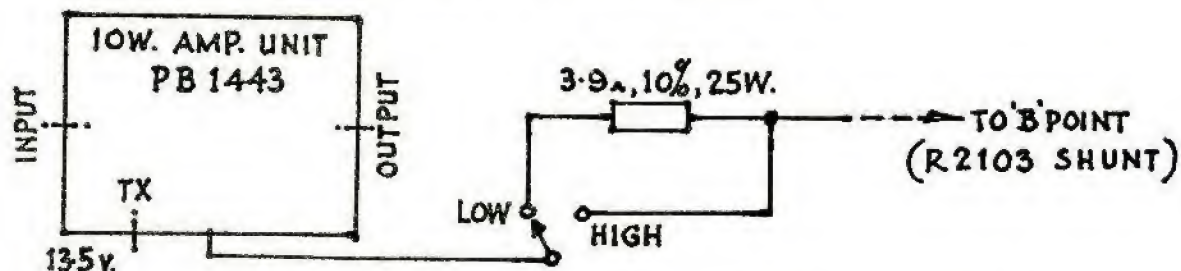
#### Results

Very good indeed. GM4FPR worked W2, W3, VE, UA3, YU, HA, UQ, UB5, I and YU during the first few days of tests. Even the GM4HBM wire, which is very "anti-28MHz", has also produced contacts, (it is to be replaced with 10m rotary dipole, so watch that DX score grow!).



## *Two Watts Out from an FT7 I7CCF*

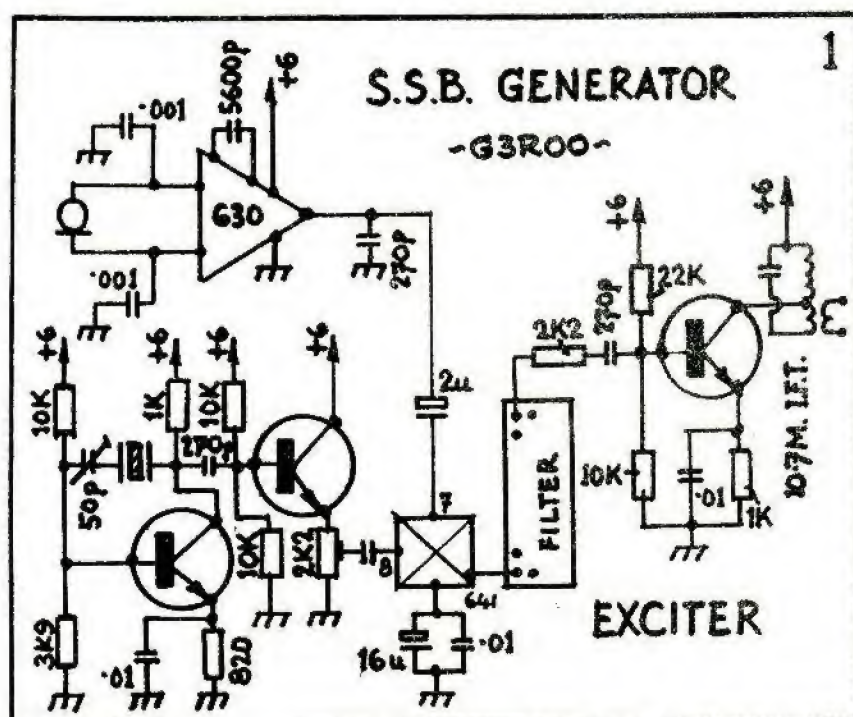
I have an FT7 transceiver of ten watts out, but I have modified the final with a switch and resistor, all in the chassis, as in the diagram below:-



The resistor is mounted in the chassis with two screws and two bands of thin aluminium (see diagram).



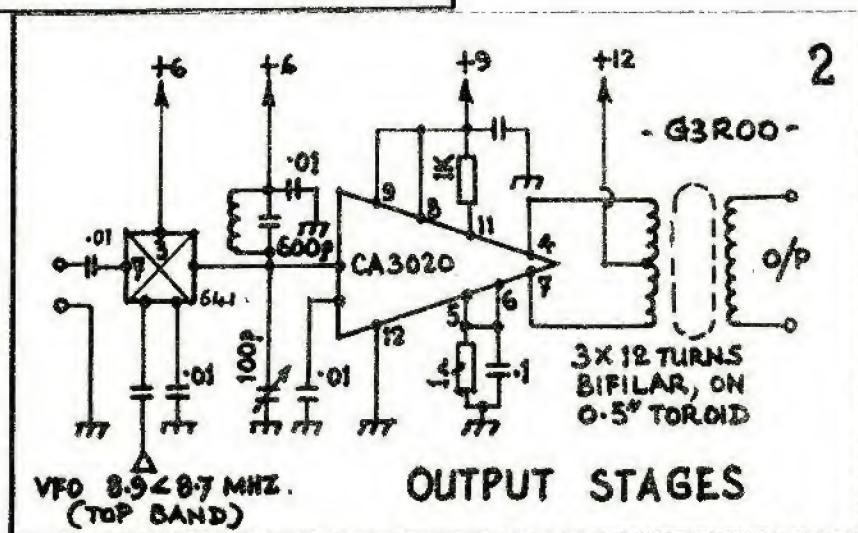
Before fixing the resistor in position, some silicon grease should be smeared between the resistor and the chassis. The switch is mounted on the rear panel in one of the two existing holes. In one position, the switch provides the maximum output power of ten watts and in the other there is about two watts output, (measured with an Osker SWR 200).



Cheap SSB  
Generator

Ian Keyser

G3R00



A small cheap generator was constructed using two of the many available 10.7MHz filters (Ambit, U.K.) intended for FM use. The idea behind the project was not to build a rig but to prove that reasonable SSB could be produced; for this reason full constructional details are not given.

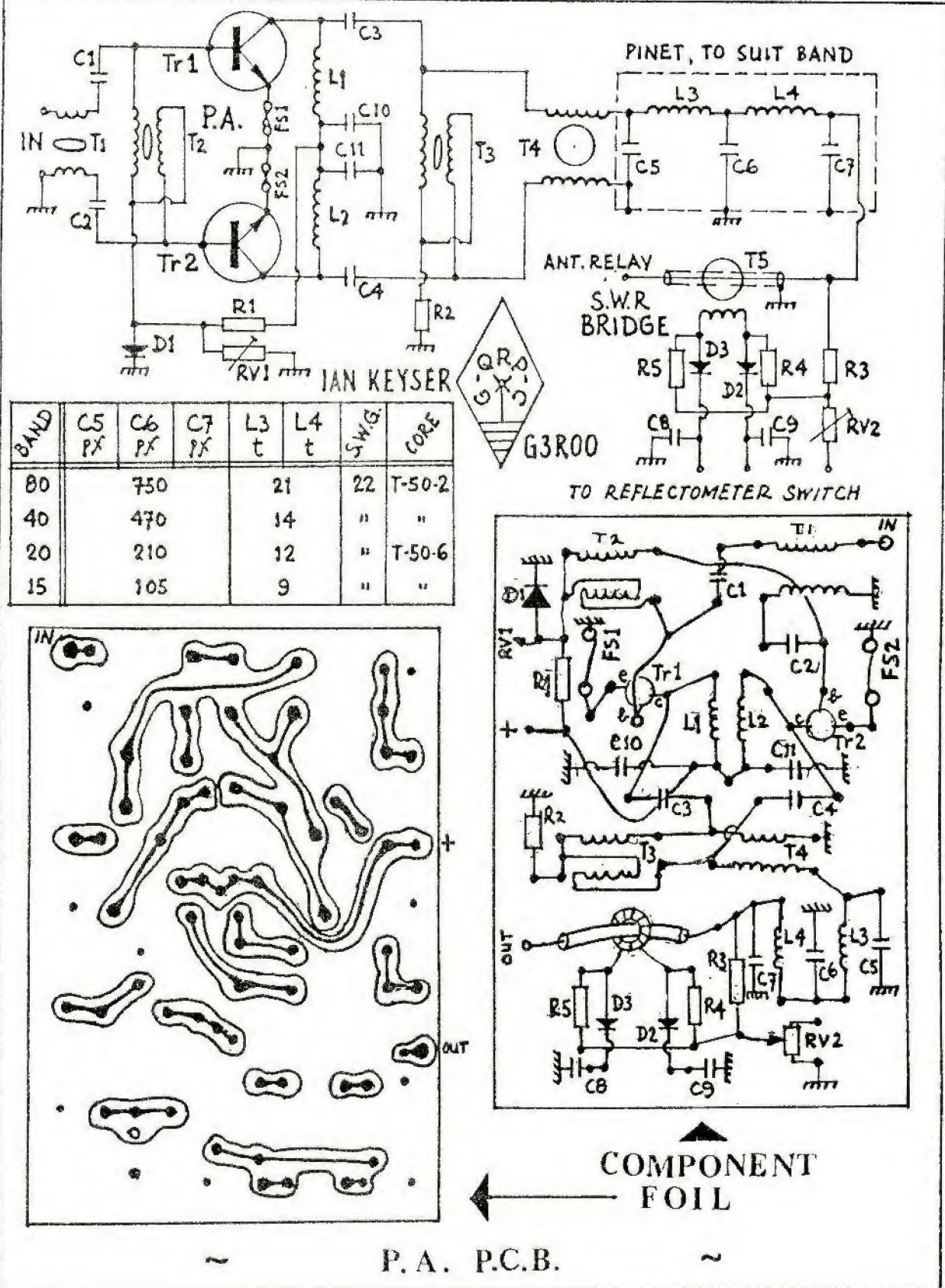
The filters used were 10.7 plus or minus 3.75KHz units, one being pulled apart to use the crystals in the carrier oscillator. If a wobulator is available it would be wise to see which filter had the best slope for the generator itself.

The unit was tested for USB, however, the carrier crystals could be switched to produce both sidebands. The crystals are set 20dB down the sides of the filter and this, with the balanced modulator, gave over 45dB of carrier suppression. The output was 100mV into 300 ohms.

The unit was tested "on air" by driving an SL641 with a low Q tuned output, which in turn drove a CA3020A to one watt on Top Band. Reports were all "good, clean but slightly topky SSB". Tests later proved that the audio was 3dB down at 700Hz, but by siting the crystal at 15dB down the side of the filter, the 3dB point came down to 500Hz. Using "Birkett IC Specials", this makes a very cheap transmitter if you can raid your friends' junk boxes!



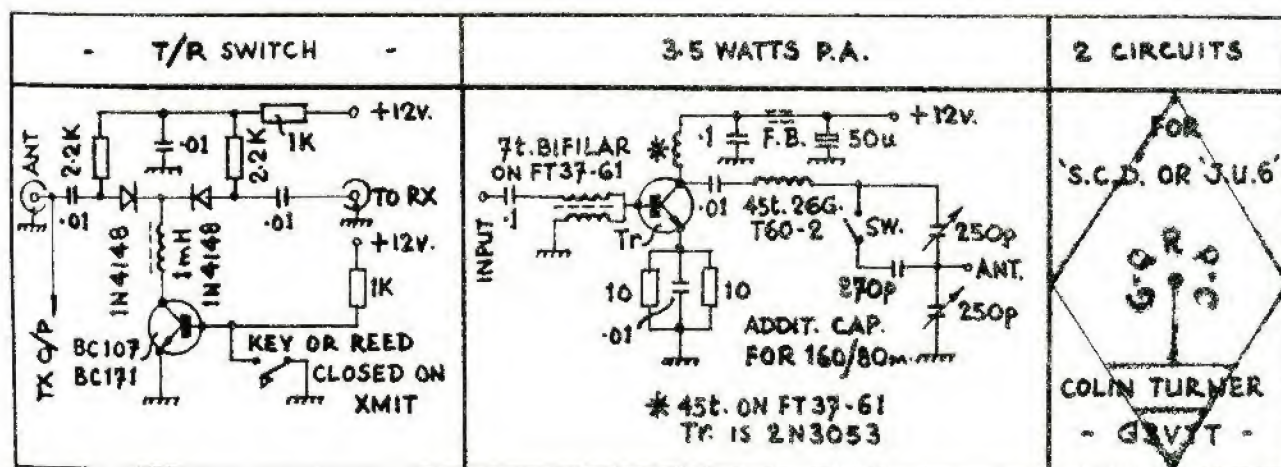
# BROADBAND POWER AMPLIFIER





Finally, a few words on winding the bifilar toroids. Take two lengths of wire of sufficient length to wind the coil, (two feet is enough for these coils), and twist them together at about three twists to the inch. Wind the required number of turns on to the ring and then identify the two windings with an ohmmeter. Now take the beginning of one winding and join it to the end of the other winding. This forms the tap on the coils. It sounds very complicated but in practice it isn't.

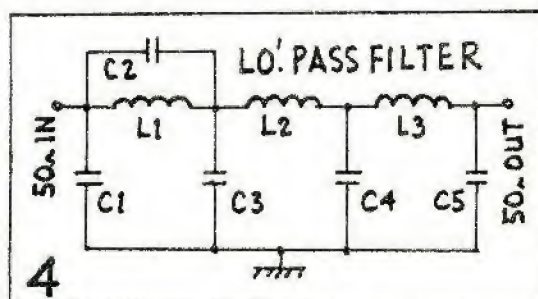
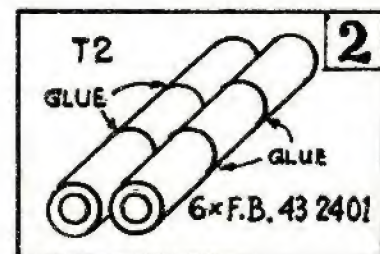
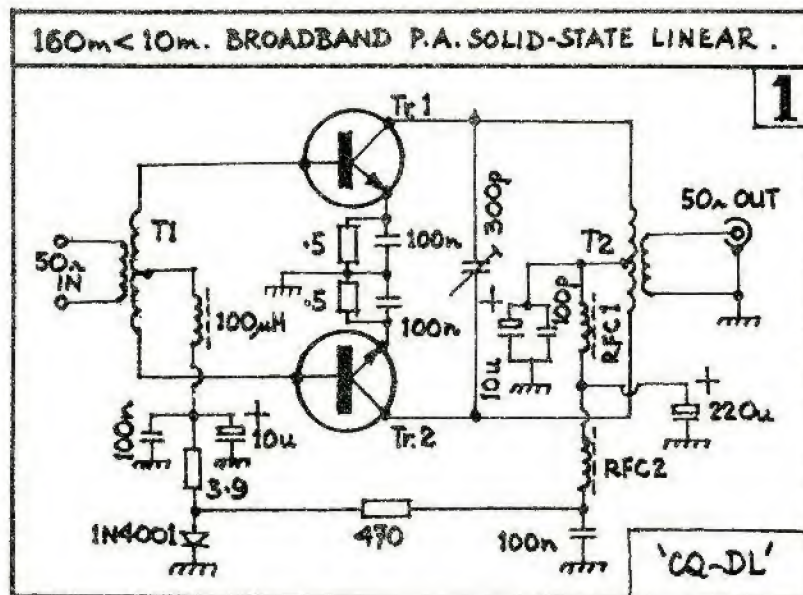
R1 - 1K $\frac{1}{2}W$	C1,2,3,4, - 0.1mfd (280)	T1,T2 - 18 turns, 26SWG, bifilar, T50-2
R2 - 3K $\frac{1}{2}W$	8,9,10,11 Mullard	T3,T4 - 14 turns, 22SWG, bifilar, T68-2
R3,4- 22K $\frac{1}{2}W$	C5,6,7 - (see table) SM	L1,L2 - 20 turns, 22SWG, single, T50-2
R5 - 22K $\frac{1}{2}W$	Fs1,Fs2 - 500mA min.	L3,L4 - (see table)
RV1 - 1K preset		
RV2 - 1K preset	TR1, TR2 - 2N3553 2N4427 etc	



Colin has been experimenting with the SCD transmitter (Short Wave Mag. Jan 1980 - available from G3ROO as a data sheet). Although untried, both the above higher powered PA stage and T/R switch could well be used with the G3DOP "JU6" circuit.

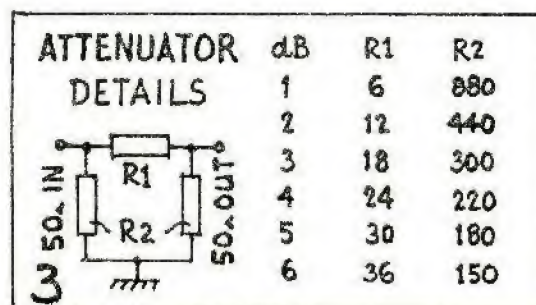


# 84 160-10m Solid State Linear P.A.



Or, use a GM30XX type of Low Pass Filter from "SPRAT" No. 20

	160m	80m	40m	20m	15/10m
C1	1600pF	800pF	390pF	210pF	105pF
C2	1360pF	680pF	330pF	180pF	90pF
C3	4400pF	2200pF	1100pF	560pF	300pF
C4	5600pF	2800pF	1400pF	750pF	390pF
C5	2300pF	1200pF	560pF	300pF	150pF
L1	2.4uH	1.2uH	0.6uH	0.3uH	0.15uH
L2	3.2uH	1.6uH	0.8uH	0.4uH	0.23uH
L3	4.0uH	2.0uH	1.0uH	0.5uH	0.25uH
Resonance (L1 + C2):					
	2.8MHz	5.5MHz	11.1MHz	20.8MHz	41.6MHz



e.g. to reduce 4 watt transmitter to 1 watt, use 6dB.

## Linear P.A.

From CQ-DL, November 1980. Translated and supplied by Gunter Dengler.

This amplifier needs about one watt input to give about ten watts output. Care should be taken to reduce the input power if it is above the one watt level (see attenuator circuit).

Although the output is via a 50 ohm link, it is advisable to use a further low-pass filter to keep unwanted products out of the antenna circuit.

The bias network of the 470 ohm resistor and associated diode give a quiescent current of about 75mA. If different output transistors are used, the value of the 470 ohm may have to be altered. The bias current should be about 5% or 10% of the maximum collector current.

### Data and Parts List

Supply voltage - 13.5v

Supply current - 1.8A approx.

Input power 160m - 20m is 0.5w, 15 - 10m is 1w.

Output power 160m - 20m is 10w, 15 - 10m is 8w.

Input and Output Impedance - both 50 ohms

Quiescent Current - 50mA to 100mA

T2 - 6 ferrite beads, FB 43 2401, glued together to form a broadband transformer  
Primary: 5 turns, 0.8mm wire, Secondary: 5 turns centre-tapped, 0.8mm wire

RFC1 - 8 turns on an FB 43 2401, with 0.8mm wire.

RFC2 - Ferrite Bead with six holes, coded green from VALVO, but Mullard type should suffice.

RFC3 - 100uH

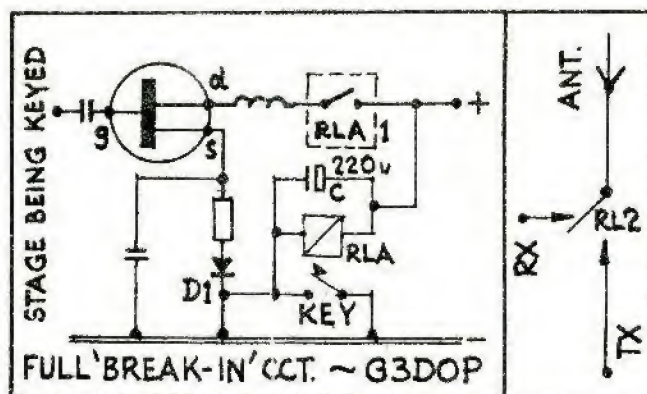
TR1 and TR2 - 2SC1307 or SHT 105

T1 - FB 43 2401 Amidon, Primary:  
6 turns of 0.6mm, Secondary  
3 turns centre-tapped of  
0.6mm.

References: ARRL Handbook 1976, Solid State Design for the Radio Amateur, etc.

## Break-in Circuit

G3DOP



Relay RLA is slugged by capacitor C (i.e. RLA is slow to release). Release time is controlled by the value of C. D1 blocks positive potential being fed via the RLA coil. If a relay with more contacts is used, C will probably have to be of higher value. In any case, the value of C can be found by experiment. The value shown allows sending at 12 w.p.m. as a minimum speed. Complete break-in is achieved by this system, thus eliminating a master change-over switch.



## W9PNE

Most of my early QRP work was done with simple crystal controlled oscillators, with DC power inputs of 1 watt or less. Being rock-bound is a great handicap to QRP work and I considered ways to add VFO capability and also more reliable operation.

The regular station equipment comprised a Drake TX4B transmitter and R4B receiver. I have an inherent distrust of pads so I didn't want to use one to reduce the power of the TX4B. I tried to operate QRP by turning down the "Gain" control but found it very unstable at the milliwatt levels. I decided that a new final, tailored especially for inputs of 500 milliwatts, would be the only answer.

I had a good supply of 6AU6A tubes in the junk box, so I built the final around one. I used a pure resistance input circuit, with a 50 ohm carbon resistor directly from the input connector to ground. This matched the TX4B nicely. With approximately 5 watts RF output from the TX4B, the RF peak voltage on the 6AU6A is about 22 volts, which is plenty of drive for the power levels intended. The TX4B was reasonably easy to hold to an RF output of about 5 watts. The 50 ohm resistor was made up of a number of 1 watt carbon resistors in parallel.

The 6AU6A operates in Class C. The 22K grid resistor provides Class C bias during excitation. A 68 ohm cathode resistor provides Class A bias under key up conditions. I also used a 3v negative bias supply on the grid, to hold the plate current lower during periods of no excitation. The same two "C" cells have been used for years.

With pure resistive input and with the excellent shielding of the little pentode, there is no instability and neutralisation is not needed. All you have to do is provide drive, dip the final and adjust the antenna loading. The exact amount of RF drive is not critical. Either too much or too little drive both reduce power output. With 500mW DC input, about 4 to 5 watts RF drive is best.

I used four 22.5v "C" batteries as the plate supply. These were very old but worked fine at the small current drain involved. I also had a small 7.5v "C" battery with a tap at each cell, to provide vernier voltage steps. By proper selection of voltage and by varying the loading, I could settle on any input power desired. To obtain 500mW DC input, I used 90v at 5.5mA plate current. For 120mW DC input, 45v at 2.7mA works nicely. A single 22.5v "C" battery produced a plate current of about 1.2mA for a DC input of 27mW.

With zero DC plate input there is zero RF power output, even with 5 watts of RF drive. The RF output is proportional to the DC plate input. At DC inputs of 250mW or less, it is necessary to reduce RF input drive to maintain efficiency.

No attempt was made to optimise the 4 pin plug-in coils, (from my junk box), for efficiency. I made measurements on several bands, using small pilot lamps as power output indicators and compared brilliance with a variable DC supply to arrive at the table below. I used a DC input of 500mW for these measurements.

80m - 55%    40m - 50%    20m - 40%    15m - 40%    10m - 20%

(NOTE: I used the 6AU6A as a doubler on 10m, because I could not control the TX4B RF output well enough on this band).

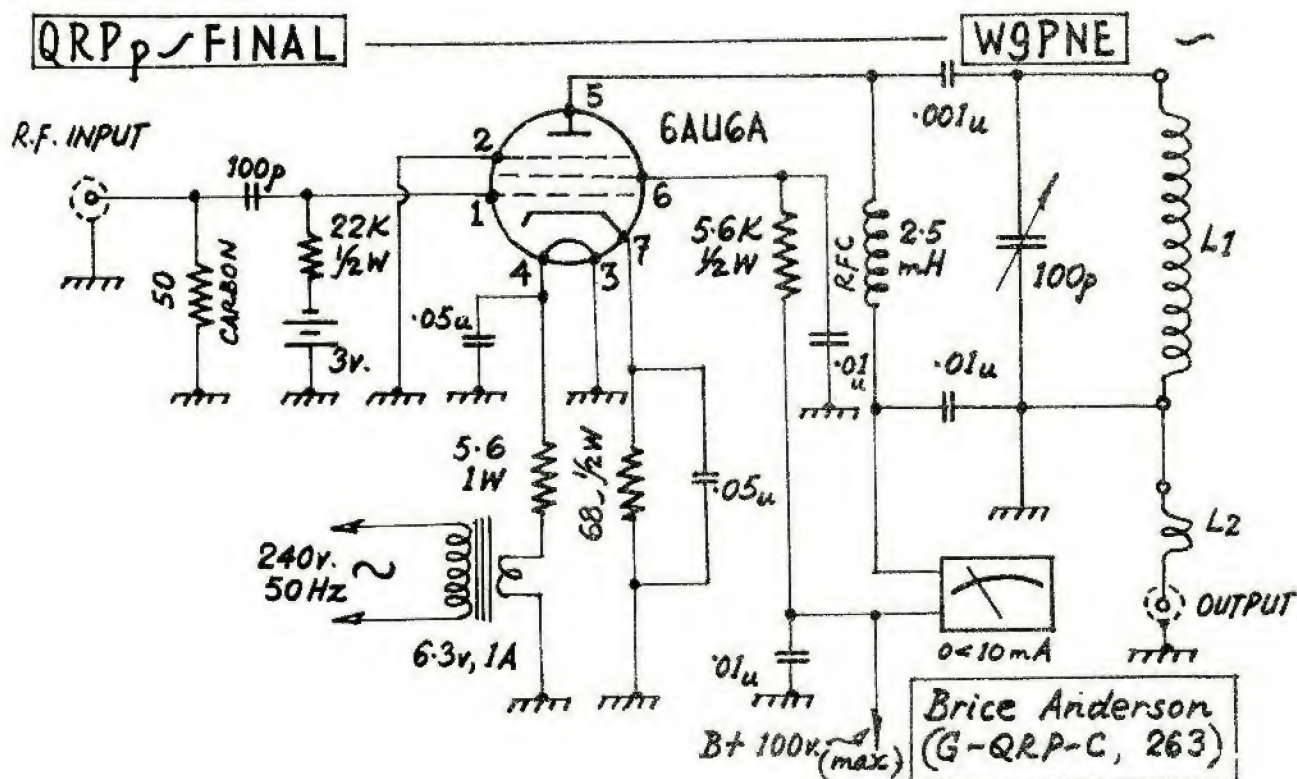
Shortly after I put the final into use, I bought a Ten-Tec Argonaut. Having become used to milliwatt levels, the 2 watts output of the Argonaut seemed like high power. However, I soon had the urge to go back to milliwatt DX. The only modification needed on the QRP final was to replace the 50 ohm input resistor with 100 ohms. The Argonaut did not mind the 2:1 match and easily drove the final. There was about 20 volts peak RF on the 6AU6A grid!

The ARRL was quick to issue me a WAS endorsed "with 500 milliwatts or less input". The certificate was dated Jan. 14th, 1975. At the time, this was the first WAS certificate issued for such low power.

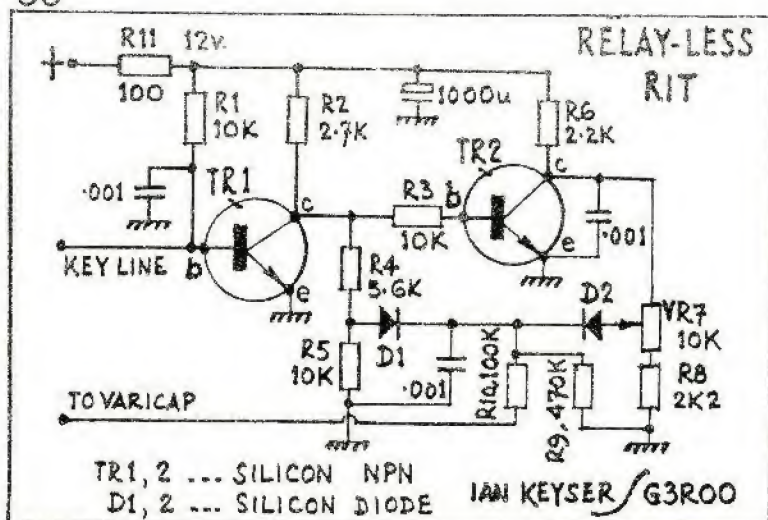
As soon as I had completed the 1/2 watt input WAS, I began working on WAS and WAC with lower power levels. The listing below shows my progress to date. Unfortunately, during the past year I have had very little time to operate.

500mW	input or less:	WAC, WAS,	36 countries
250mW	" " "	W5C, W46S,	16 countries
150mW	" " "	W2C, W34S,	5 countries
100mW	" " "	W2C, W33S,	4 countries
50mW	" " "	W1C, W16S,	2 countries
25mW	" " "	W1C, W2S,	(Indiana & New York)

I have two main antennas, a long wire and a vertical. Most of my QRP work has been done with the long wire, although the vertical is best for DX to JA and Eastern EU. The long wire is a 456 ft flat top, center fed with 40 ft of open tuned feeder. It is 50 ft high at the center but the average height is about 40 ft. The vertical is a Hustler Model 4BTV trap vertical, 20 ft above ground.







*Relayless RIT*

*Ian Keyser G3R00*

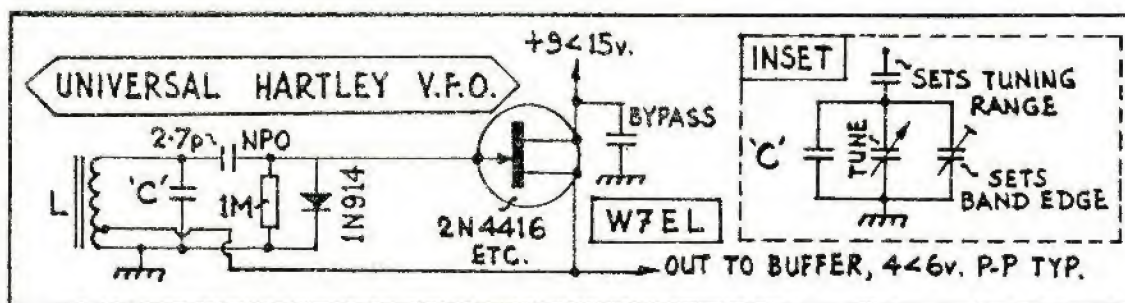
I was recently asked how an RIT system could be accomplished without the use of a relay, and be keyed by the keying line. This circuit was designed and the only demands on the keying line are that in the key-up mode the line must rise above 2 volts and in the key-down it must be below 2 volts. In some cases this range could be considerably less. It costs the same as a good 12v relay (and its quieter).

#### Key-up Mode

R1 causes an  $I_b$  of 1mA, turning TR1 hard on and reducing the collector voltage to near zero. Therefore no base current. TR2 allowing the collector to rise to 10 volts (potential divider R6, VR7, R8). The anode of D2 takes up the potential of the slider of VR7, between 3 & 9 volts. The anode of D1 is at zero volts (the collector of TR1 is at zero), so D1 is therefore back-biased. The varicap bias is 0.6v below the slider of VR7 due to the voltage drop across D2.

#### Key-down Mode

TR1 turns off and its  $V_c$  therefore rises to about 8 volts (compound divider R2, R4, R5, R3 and base of TR1) and the anode of D1 rises to about 6 volts. Approximately 1mA of base current in TR2 turning it hard on and  $V_c$  drops to zero. Therefore the slider also drops to zero. D2 is now back-biased and therefore the bias to the diode is 0.6 volts below the anode of D1, as D1 is now forward biased.



L: Wind tightly on Type 6 powdered iron toroid, size -37 to -50 (or 50), e.g. T-44-6. After winding, boil for 1 minute in water and allow to cool in air. Tap a quarter of the way from the bottom. X1 should be about 150 ohms at operating freq.

C:  $X_c$  should also be about 150 ohms at operating freq. If desired, some or all of C may be connected from tap to ground, but C connected to tap must be 16 times as large. Use air or NPO ceramic dielectric. Can temperature compensate by replacing some of the C with polystyrene or negative temperature coefficient units.

Do not build on PC board over a ground plane. Stray capacitors with board as a dielectric have very poor temperature characteristics.

Typical performance (40m): Warm-up drift 100 - 200Hz (downward), about half occurs in first 1 to 2 minutes. Frequency will change 50-80Hz per volt of supply change.



T1	-	2N5770 or similar VHF NPN
T2, T3	-	2N3704 or similar NPN
L1	-	4.3uH 15:1
L2	-	4.3uH 10:1 + 1 (Note: Original used extra transformer to obtain correct ratio)
L3	-	4.3uH
L4	-	680uH Input tap 2/7
L5	-	680uH 7:1 Output tap 1/7

Tuning Capacitor - Three gang 310pF (Jackson 5084/3/310)

Capacitors: AL Electrolytic, if greater than 1mf  
Ceramic, if smaller than 0.1mf  
Silver Mica in L.O. only

Capacitors under 1000pF may be polystyrene, but if used in L.O., stability may suffer.

I.M.D.: 3rd order intercept point +8dBm

[illegible]



## PASS THAT BAND! David Reynolds G3ZPF

Real QRP miniaturisation means that front panel controls must be reduced to a minimum. Pre-tuned TX output circuits and RX input circuits help to achieve this. Figs 1 & 2 show suitable circuits for the HF bands. Component details are given in Tables 1 & 2. The insertion loss of the TX output filters is very low, from 0.1dB at 1.8MHz to 0.3dB at 28MHz. All the transmitter coils are wound on Amidon T-80-2 toroid cores. The 80/40m receiver coils are wound on T-50-6 cores and the 20/15/10m coils on T-50-10 cores. GW3TMP (QTHR) is the UK Amidon stockist of these cores. Note that the TX coils are specified in US wire gauge, the UK equivalent being 18SWG. Metric equivalents of the wire sizes are:- 1.1mm (18), 0.6mm (22), 0.5mm (24) and 0.03mm (28). Also note that the tap on L3 in Fig 2 may have to be adjusted experimentally to provide a good match to the RX input device. The use of an antenna tuning unit is recommended with the circuit of Fig 1.

TABLE 1 - TX OUTPUT CIRCUITS

160m	80m	40m	20m	15m
L1 26t 18SWG	L1 18t 18SWG	L1 15t 18SWG	L1 10t 18SWG	L1 9t 18SWG
L2 23t 18SWG	L2 16t 18SWG	L2 13t 18SWG	L2 9t 18SWG	L2 8t 18SWG
C1 200pF	C1 100pF	C1 51pF	C1 24pF	C1 15pF
C2 680pF	C2 300pF	C2 160pF	C2 75pF	C2 51pF
C3 1000pF	C3 560pF	C3 270pF	C3 150pF	C3 100pF
C4 2000pF	C4 910pF	C4 500pF	C4 250pF	C4 160pF
C5 820pF	C5 390pF	C5 200pF	C5 100pF	C5 68pF

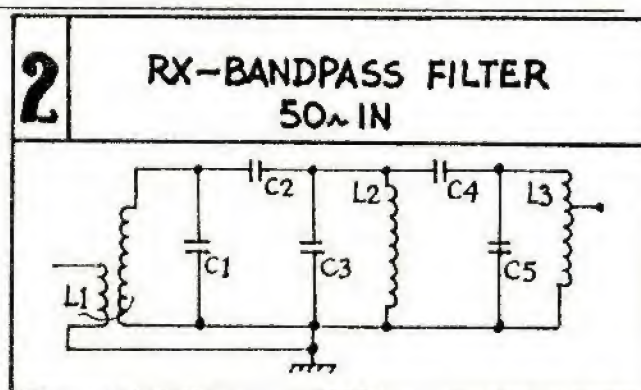
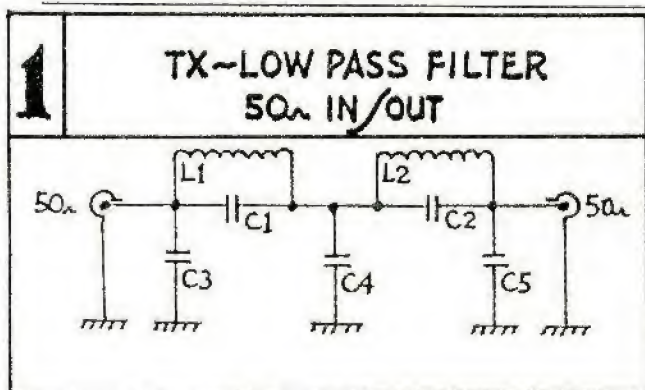
10m:- L1 8t 18SWG, L2 7t 18SWG, C1 10pF, C2 39pF, C3 68pF, C4 120pF, C5 51pF

TABLE 2 - RX INPUT CIRCUITS

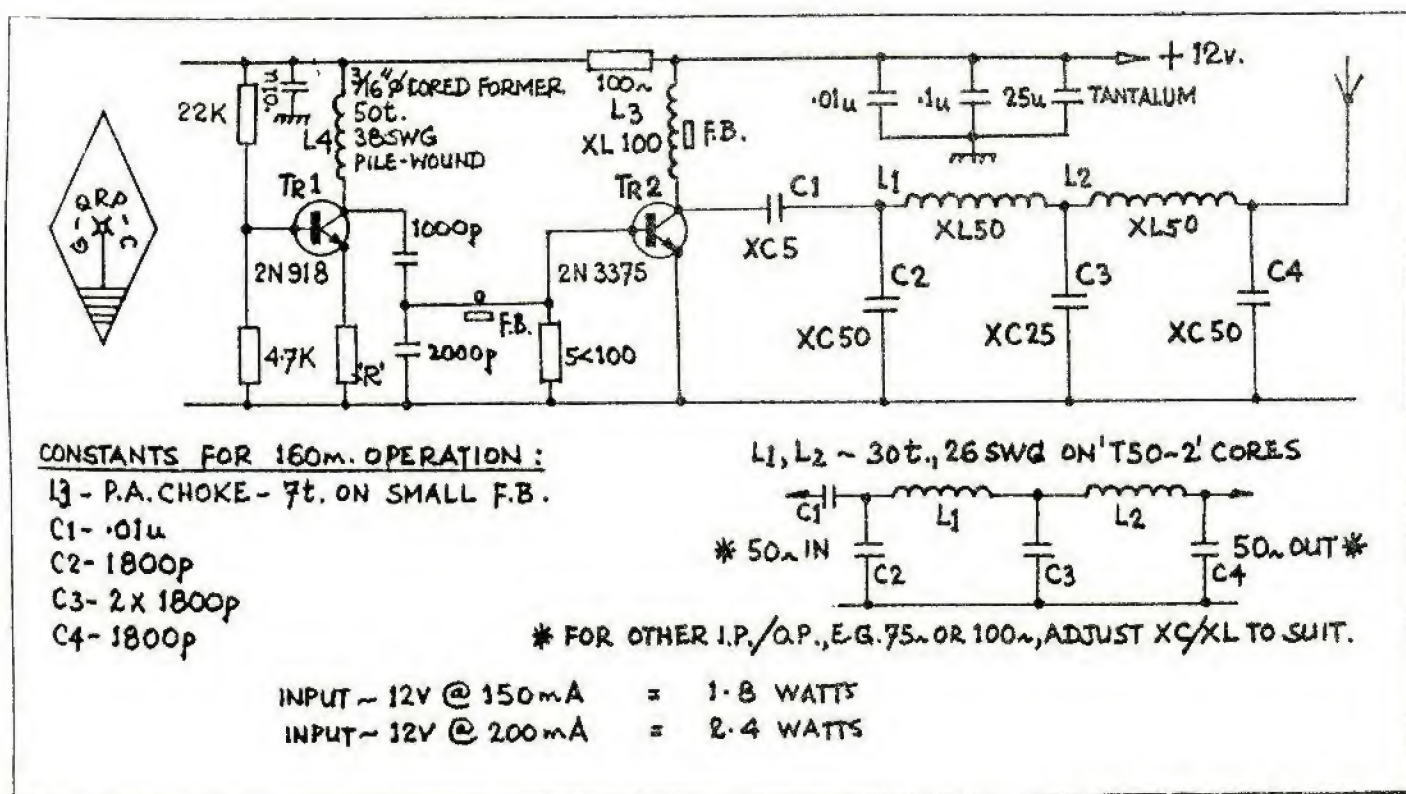
80m	40m	20m
L1 - 59t, 28SWG, link 12t	L1 - 23t, 24SWG, link 5t	L1 - 16t, 22SWG, link 3t
L2 - as L1, less link	L2 - as L1, less link	L2 - as L1, less link
L3 - as L1, tap at 42t	L3 - as L1 tap at 17t	L3 - as L1, tap at 10t
C1 130pF, C2 15pF, C3 100pF	C1 200pF, C2 8.2pF,	C1 120pF, C2 3.9pF,
C4 15pF, C5 115pF	C3 200pF, C4 8.2pF,	C3 120pF, C4 3.9pF
	C5 200pF	C5 120pF

15m	10m
L1 - 10t, 22SWG, link 2t	L1 - as for 15m
L2 - as L1, less link	L2 - as for 15m
L3 - as L1 tap at 7t	L3 - as for 15m
C1 120pF, C2 3.3pF, C3 120pF	C1 60pF, C2 2.2pF, C3 60pF
C4 3.3pF, C5 120pF	C4 2.2pF, C5 60pF



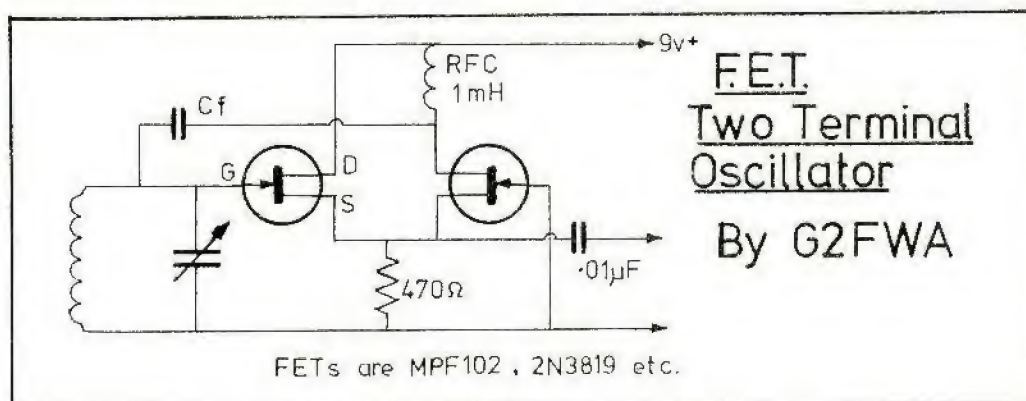
## PA Design Idea George Burt GM30XX



Further design information can be gleaned from "Solid State Design for the Radio Amateur" by the ARRL.

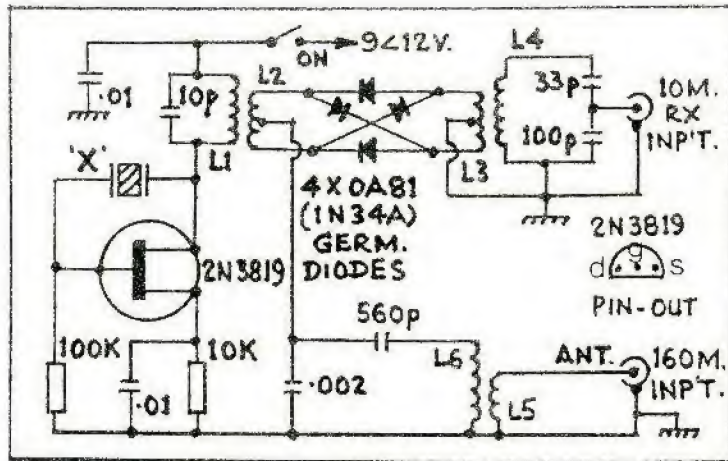
PI-NETWORK VALUES	80m:	C2, C3, C4 - 750pF	L1, L2 - 21t, 22SWG, T-50-2
FOR OTHER BANDS:-	40m:	" " " - 470pF	" " - 14t, " "
	20m:	" " " - 210pF	" " - 12t, " T-50-6
	15m:	" " " - 105pF	" " - 9t, " "

(Capacitors close tol. silver mica, or smaller "poly" type, matched on a bridge)



This circuit is equivalent to the twin-triode cathode coupled oscillator. By merely changing the tank circuit constants, output can be obtained from below 1MHz right up into the VHF region. 30pF is a good compromise for the feedback capacitor Cf.





## Basic 160m Converter

G3RJV

For readers without a 160m receiver, the above circuit offers about the simplest convertor. It is the circuit from QST by Alan Bloom, WA3JSU, adapted for UK parts. 10m offers a handy tunable IF as it is usually not too good when 160m is useful. The high output frequency and no conversion gain prevent IF breakthrough and IMD and lack of gain is no real problem on Top Band. I knocked it up in a couple of hours in an old, well-drilled box and fed into the Argonaut 505 receiver on 10m. Results have been good for what the circuit entails. UK SSB and Continental CW signals have been received without any problems.

L1 - 13 turns 36SWG

L3 - 2 turns 22SWG ct.

L5 - 5 turns 22SWG

L2 - 2 turns 22SWG ct.

L4 - 8 turns 22SWG

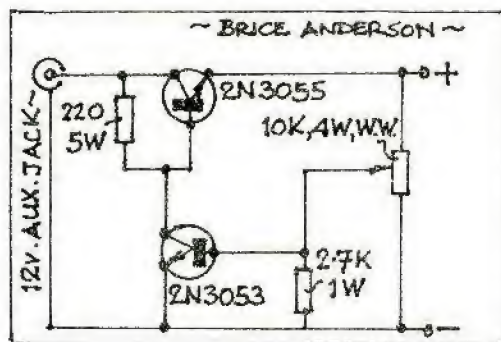
L6 - 33 turns 36SWG

All coils on  $\frac{3}{8}$  inch (10mm) former, with slug.

"X" was 26.61MHz (1.8 to 2.0 equals 28.41 to 28.61MHz). Any crystal to cover 10m band minus 160m would serve. Other bands could be used as an IF with suitable junk crystals and alteration of L1,2,3 and 4. (Peak L1 with diode probe and meter and peak L4 and L6 in use).

## Variable Voltage Regulator for the Argonaut

W9PNE



This simple and inexpensive voltage regulator provides from zero to 11 volts of very well regulated power for operating the Argonaut final at reduced voltages.

The Argonaut requires low voltages for efficient use in the milliwatt ranges. The Argonaut 515 needs a lower voltage than the 505 or 509, for a given input. I have found the following values are optimum:-

100mW input - 1.1 volts at 90mA  
250mW input - 1.7 volts at 140mA

500mW - 2.5 volts at 200mA  
1 watt - 3.3 volts at 300mA

Be sure to monitor the output power, as an increase in drive past the optimum point causes a power output drop. I use external meters, but both the regulator and meters could be built into a small cabinet







## Crystal Grinding for the Novice G.J.Bennett G3DNF

Why use crystals for the HF and LF bands? Many have asked themselves this question and decided not to. Crystals made to order were never cheap and the supply of surplus ones for the amateur bands has dried up. Anyway, it is now so easy to build a rock steady VFO that the advantage of crystal control may not be so apparent.

However, there are circumstances in which crystals are better than a VFO. For portable or /A operation the use of crystals avoids the need to carry a crystal calibrator. The easiest way to get started with CW on the amateur bands is by building a CO/PA transmitter.

Although there is no longer a good supply of surplus crystals for the amateur bands, there are still plenty of cheap "useless frequency" crystals available outside the amateur bands and it is possible to make use of some of these by regrinding them. This is often shrugged off as "too difficult" or "time consuming". In fact, very little practice is needed to master the basic skills required. It is the purpose of this article to pass on to the beginner as much information as is needed to make the first attempt. The writer cannot claim to have superior knowledge or skill, except that gained the hard way, by experience. Like most basic skills, it is easier to show than to convey in writing, but let's see what can be done.

First, it is obvious that crystals mounted in hermetically sealed cans are not suitable for grinding. The old styles of mounting (in use up to the fifties) such as FT243, 10X and 10XJ permit the removal of the crystal plate. In these mountings the crystal is sandwiched between two metal plates, each of which has a raised area at the corners (for square or rectangular plate) or around the edge (circular plate) see Fig 1. N.B. Some of the later HF crystals in the 10X guise are actually constructed like the hermetically sealed types, with electrodes plated onto the quartz plate. These should be avoided; they are much lighter in weight than the usual 10X package.

For a beginner, the best plan is to start with a fairly large, easily handled plate. Typically this should be a 10X type with a frequency of about 3000KHz, for regrinding to the 80 metre band. Such a crystal will be about one inch square and one sixteenth of an inch thick.

The equipment needed is as follows:-

- Carborundum Powder (two grades - see note below)
- Paper Tissues (toilet, kitchen or handkerchief types)
- Saucer or shallow dish, and a glass plate
- Screwdriver
- Test Oscillator (see Fig 2)
- Amateur band or general coverage receiver
- Tube of Toothpaste
- Add water, patience, and off we go...!

Using a test oscillator, check that the crystal oscillates and note the frequency. Some old crystals are inactive but in most cases this can be cured. Open up the crystal holder over a tray or cloth, so as not to lose the parts. Withdraw or unscrew the spring tensioner and gently tip out the metal plates and quartz sandwich onto a tissue. Examine all parts for traces of dirt or corrosion.

To clean the quartz and metal plates, rub them gently between the finger and thumb with a little toothpaste and water. Rinse well with water, blot with a tissue, allow to dry in warm air and re-assemble. Check the frequency and activity again. This treatment will often make a "dead" crystal come to life again. Note that



toothpaste (the white kind) is used instead of carbon tetrachloride which is toxic and less effective as a general cleaning agent where plain dirt, as distinct from grease, is concerned. Avoid fingering the quartz plate during the drying and re-assembly. Hold it by the corners, between finger and thumb, or use plastic tweezers (see Fig 3).

Two types of carborundum powder are required for this operation. Fine grit (often referred to as carborundum flour) and medium grit. Both are easily obtainable in small quantities by purchasing a beginners' rock polishing kit. This will contain a few pieces of rock (real rock!) and four tubs of powder (coarse, medium, fine and polishing powder). These kits can be bought for less than £1 at many hobbies shops. Only the medium and fine carborundum will be required.

Place the glass plate on a steady table. Put some water in the saucer and stand it near the plate. Sprinkle a good pinch of medium carborundum in the centre of the plate and add a few drops of water, enough to make the powder swim but do not drown it. Work the paste out to a patch about three inches wide with the finger before placing the crystal on it.

Throughout the grinding, use a steady pace and even pressure. Never grind for too long without shifting the area of pressure on the crystal. Remember the aim is to obtain perfectly plane and parallel faces. Use the tips of the index and middle fingers to apply the pressure when dealing with the larger crystals such as the LF 10X types.

The first few strokes will break down the grit a great deal, so just give a couple of rubs, clockwise, with the finger tips on the diagonal AC (see Fig 4). Next, reverse the direction and give a couple of strokes anti-clockwise. Now turn the crystal through  $90^\circ$ , shifting it to the diagonal BD. Repeat two strokes each way and turn another  $90^\circ$  and repeat, turn again and repeat, until the crystal has had a total of 16 rubs, evenly distributed on one side. Now turn the crystal over and repeat the above procedure. Rinse the crystal in the saucer, wash it well in running water, then allow surplus water to drain off, while holding it by its corner (Fig 3). Carefully blot with a tissue then dry it in warm air or under a lamp.

Remount the crystal into the holder and check the frequency. It may not have moved far, but the change should be measurable. The grinding can now continue using more strokes, say ten each way. The only way to judge is to measure the result. Never let the grinding bed become too dry. Add more grit as required. If too much water is added it slows down the cutting rate of the paste. Keep the grinding track well distributed over the glass plate by working the tracks in overlapping circles (Fig 5). The grinding process also removes glass from the surface; avoiding local wear will improve the chances of a properly ground crystal.

Check the progress at intervals and take care not to overshoot the target frequency. When the crystal approaches the target, say 3400 for a target of 3500, stop using medium grit. Wash the plate clean and turn it over. Use the fresh surface to continue grinding with fine carborundum. The cutting rate will be slower, but easier to control. As the target frequency is approached, check more often. With practice, it is possible to grind to within 1KHz or better.

The grinding of a crystal from 6500 to 7000KHz is also feasible. Such crystals are only about half the size of the example described above; it following that the grinding of the thin quartz requires more care. Use only fine grade powder and apply pressure with the tip of the forefinger. The final stages are tricky, as a single rub can make a difference of 1KHz. It is a matter of fact that the grinding of a crystal causes microscopic surface damage, which can affect long-term stability. For this reason commercial crystals are etched to the final frequency after grinding. Etching entails the use of dangerous chemicals and should not be undertaken lightly. Even without etching, crystals which have been ground are quite



satisfactory for amateur use. Occasionally, a crystal ground to a spot frequency "settles down" after a few months to a slightly different frequency (say 1KHz in 7000). This is unlikely to be a matter of concern in a CO/PA transmitter but, for a filter or SSB oscillator, it must be etched to final frequency and that is a different story.

If reasonable care is taken over grinding, the chances of success are high. A crystal that fails to perk after grinding can often be restored by the "toothpaste treatment", but little can be done for badly ground or scratched crystals which fail to oscillate or behave properly. Corrective grinding is difficult and is likely to take the crystal out of the target band. It is far better not to spoil the crystal in the grinding; the temptation to hurry must be resisted.

The first attempt will take longer than the rest. With practice, several crystals can be ground in an evening. Forget any ideas of relaxing after such a performance by doing a bit of snappy CW. Your hand will feel as though it has been through the wringer! A more domestic hazard can arise through sloppy disposal of waste carborundum. It can play havoc with the glaze on a wash basin if traces are left for someone else to clean off. Pouring it through a waste disposal unit will also prove expensive.

The economically minded can recover some of the carborundum by washing the spent paste, but the stuff is so cheap that it is hardly worthwhile. In any event, at all costs keep the grades of grit separate. If the fine grade becomes even slightly contaminated with the coarse it will be ruined. When it is intended to grind several crystals it is better to grind them all with the coarse grit first, then transfer to the fine grit.

